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On Working Plans.

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Contents.

INTRODUCTORY.

Most of the readers of this journal will have seen at page 104 of the Report of the Proceedings of the Forest Conference, held at Simla in October 1875, that I commenced my paper on Preliminary Working Plans with some remarks and explanations on the normal state of forests. Although I had drawn up some notes on the subject, they were not printed in the *Conference Report*, because I wished to improve them, and to adapt them more to Indian circumstances. Experience, however, has proved to me, that, with my duties as Conservator of Forest of a large Government and the Editorship of the "Indian Forester," not sufficient time is left at my disposal to carry out my original intention. On the other hand, I consider it high time, that endeavours be made to try and supply to those, who had no opportunity of studying forestry at home, or who are not acquainted with continental languages, the means of making themselves acquainted with the general principles upon which forest management should be based. This can be done by translating the best German and French works on forestry into English, and great benefits will be derived by following that plan. In fact, Messrs. Fernandez and Smythies have earned the thanks of Government and of all Forest Officers by translating the "Manuel de Sylviculture," by Bagneris, into English, of which book a new edition, available to the general public, is about to be issued. On the other hand, Mr. B. Ribbentrop in his "*Hints on Arboriculture*" has at once written an Indian book, based on the general principles of Arboriculture, or rather Sylviculture.

I feel that I have to some extent pledged myself to do something towards bringing the principles, on which working plans should be based, before Indian Forest Officers; but at the same time I do not possess sufficient confidence of producing something original, which would be found up to the required standard. Under these circumstances I shall adopt the plan of publishing a series of articles on the subject in the pages of the "Indian Forester," giving materials which have been obtained, partly by translating from continental works, and partly by adding what experience I have gathered in India.

Before proceeding to business, one word more: In the management of the German State forests the financial principle, that is to say, the management of the forests in such a manner as to secure, as far as practicable, the highest possible interest on the invested capital, has been asserting its rights of late years. Though it is, generally speaking, the only correct principle to start from, and then to modify the conclusions arrived at by means of it according to the special circumstances under consideration at the time, in the present state of Indian forestry I should meet with endless difficulties, were I to follow strictly the above principle. Before we can do so here in India, we must first bring our forests under a more regular management. When this has been done, it will be time enough to begin and calculate interest, and these remarks should be remembered when judging of the method, according to which I have treated the subject of working plans in the following pages.

2. The financier, who has to prepare a budget, has to do with one year's income and expenditure, which he has to balance; he deals chiefly with circumstances referring to one particular year.

On the other hand, the income of a forest, or its annual growth, has to be stored up for years, until it becomes of such quality, as to be of material use; consequently a certain stock of collected annual incomes has always to be kept in a forest, in order to allow of mature timber being removed; and the forester, in preparing his budget, or working plan, has to take into consideration the incomes or growths of a series of years; he has to ascertain the laws which govern the growth of trees from infancy to maturity; his expenditure, or wood to be cut in a certain year, represents the income or growth chiefly of past years, whereas his income during the same year will generally have to be kept for future years. This peculiarity of forestry enables an unscrupulous or careless forester to devastate a forest, by removing, not only an adequate annual yield, but in addition a portion of that stock of growing material, without which it is impossible to secure a permanent yield of mature timber. On the other hand, if a forester removes less than the forest can stand, he acts contrary to the interest of the owner.

3. To prevent either the one or the other, working plans are necessary, and it is difficult to understand, why of all measures introduced for the better management of the Indian State Forests, none perhaps has met with so much resistance, as they have. In some cases it was thought, that working plans are not necessary at all, and in others it was considered, that the time for their introduction had not yet come. These views were the result, partly of one-sided ideas, and partly of attempts to introduce working plans too complicated to be understood by those who were expected to carry them out.

4. The man who spends his money without ascertaining the limits of his resources, is liable to become insolvent. Experience has shown the immense importance and necessity of well-arranged state budgets, and there is no reason, why forests should be inexhaustible, or why they could be managed rationally without a well-considered plan. On the contrary, of all things a forest is liable to be mismanaged without a previous plan of operations.

5. During the last few years matters have altered considerably, and there are few Forest Officers now in India, if any, who are not impressed with the necessity of managing the forests under their charge according to some fixed plan.

6. What is a working plan? To answer this question in a few words is somewhat difficult, because the meaning of the term comprises a great many different objects, but in a general way it may be said, that *a working plan should measure the yield and regulate the management of a forest in the manner most advantageous to the owner.* The interest of the owner differs according to circumstances. In one instance it may consist in managing a forest so as to effect certain climatic results, or it may be to derive the highest possible quantity of produce of certain kinds, or the highest possible annual revenue, or the highest possible interest on the capital invested in the forest. In each of these cases the forest will have to be managed in a different manner, and in order to ascertain what kind of management is indicated by the condition of a forest, or how a certain management bears upon the resources of the forest, certain researches have to be carried out in the forest and certain rules for its management have to be drawn up, the sum of which may be understood under a working plan.

7. Every forest is expected to give a certain yield or return to the owner. Under yield is understood the quantity of material removed annually, or periodically. The size of the yield depends on the will and pleasure of the owner of a forest, but it is naturally limited, on the one side by the amount which grows annually, and on the other side by the growing stock available in the forest.

8. There are two distinct methods of working a forest permanently :—

(1.) *The strictly annual working,* when the full growth is removed in equal annual parts, the material being at the same time of the normal or fixed age.

(2.) *The periodical working,* when an annual yield is not insisted on, but when the different compartments or blocks are cleared whenever the forest on them reaches the normal or fixed age.

This distinction should be particularly noted before proceeding to the first chapter.

CHAPTER I.

*On the Normal State of Forests.**

9. Most forests are in a more or less irregular condition. There are blanks, or only young trees, or only old trees. This condition is called the *real state* of a forest, that is to say, the state in which the forest actually is at a certain time. On the other hand, a state can easily be imagined, in which everything is as it ought to be, there are no blanks, there is a proper proportion between old, middle aged and young trees, and a vigorous growth prevails all over the forest. This condition is called the *normal state* of a forest. The principal object of a working plan is, to lead the real state over into the normal state, and afterwards to keep it in that state. The points to be considered are :—

(1.) What is the normal state ? and

(2.) How is the real state to be led over into the normal state ?

* This and the next chapter consist almost entirely of a translation from Professor Dr. Gustav Heyer's teachings.

SECTION I.

Fundamental Conditions of the Normal State.

10. These are three in number :—

(a.) Normal age classes ;

(b.) Normal growth ; and

(c.) Normal growing stock.

NORMAL AGE CLASSES.

If a forest is managed with a rotation of 100 years, the trees to be cut annually should be 100 years old, and in order to have such trees year after year, it is necessary that there should be 100 age classes, the oldest 100 years old, and the youngest 1 year, with an equal difference of 1 year between every two classes. These are called a series of normal age classes. They can be distributed over the forest in different ways. Young and old trees may be mixed over the whole area, which is the case in most Indian forests, or a certain number only may be found on a portion of the area ; for instance, all trees between 100 and 80 years on one-fifth of the area, those between 80 and 60 years on another fifth of the area, and so on. Thirdly, each age class may be found on a separate portion of the area, so that there would be, in the above instance, 100 different compartments each containing trees of the same age only, differing by one year from that in the next compartment. The latter may be called the perfection of normal age classes.

11. NORMAL GROWTH.

The following kinds of growth should be distinguished :—

(1.) *Normal growth*, which is the growth obtained if no extraordinary events have influenced it.

(2.) *Real growth*, which is the growth obtained under extraordinary influences.

The normal growth is that, which is obtained in a normal forest, where no blanks are met with, where the normal age classes and the normal growing stock exist. The nearer the real state of a forest approaches the normal state, the nearer will the real growth approach the normal growth.

12. In most natural forests the real growth will be smaller than the normal growth, but circumstances may occur, in which

the two are not only equal, but in which the real growth is larger than the normal growth, because the latter must not be understood to be the largest that can possibly take place, but that which can reasonably be expected in a normal forest.

13. Normal, as well as real growth, may refer to one particular year, or to a number of years, hence there may be further distinguished:

(3.) *Current annual growth,* or that which actually takes place in a certain year, and

(4.) *Average annual growth,* which is calculated by dividing with a number of years (generally that of the rotation) into the total growth accrued during those years.

14. A peculiar relation exists between the current annual and average annual growth, which it is necessary to explain here. The annual growth of a tree, and consequently of a forest, differs according to the age of the tree. Generally it is small at first, then with the age of the tree it increases, until there comes a time when it is stationary, after which it begins to fall off, until it sinks down to zero at the natural death of the tree. Consequently the current annual growth may be smaller, equal or larger, than the average annual growth.

15. As long as the current annual growth rises, it is greater than the average annual growth; then, when the former begins to fall, there will be a year, when they are equal, after which the average annual growth will be greater than the current annual growth.

The following example will illustrate this :—

Year.	Current annual growth.	Average annual growth.	Year.	Current annual growth.	Average annual growth.
1	1	1	9	7	$4\frac{7}{9}$
2	2	$1\frac{1}{2}$	10	6	$4\frac{9}{10}$
3	3	2	11	5	$4\frac{10}{11}$
4	4	$2\frac{1}{2}$	12	4	$4\frac{10}{12}$
5	5	3	13	3	$4\frac{9}{13}$
6	6	$3\frac{1}{2}$	14	2	$4\frac{7}{14}$
7	7	4	15	1	$4\frac{4}{15}$
8	8	$4\frac{1}{2}$	16	0	4

The current annual growth is greatest in the 8th year, and the average annual growth in the 11th year. After the first year and up to the 11th year the current annual growth is greater than the average annual growth. Between the 11th and 12th years they are equal, and after that the average annual growth surpasses the current annual growth.

16. This peculiarity teaches us a great lesson, namely, that the greatest quantity of material is obtained with a rotation equal in years to that of the greatest *average* annual growth, and not equal to that of the greatest current annual growth. In the present instance the most advantageous rotation, as far as quantity is concerned, would be that of 11 years, and not that of 8 years, as the following calculation will show :—

After 8 times 11, or 88 years, both rotations fall together. During these 88 years the material produced with a rotation of 8 years would be equal to $(1+2+3+4+5+6+7+8)\ 11 = 36 \times 11 = 396$ cubic feet. With a rotation of 11 years, there would be $(1+2+3+4+5+6+7+8+7+6+5)8 = 54 \times 8 = 432$ cubic feet, or 36 cubic feet more, than with a rotation of 8 years.

If, on the other hand, the rotation is raised beyond the highest average annual growth, less material will be produced.

NORMAL GROWING STOCK.

17. It has been shown above, that, in order to cut mature timber year after year, it is necessary to have a considerable stock of growing material of all age classes. Under normal growing stock is understood the sum of predominating growing material in a normal forest. Under real growing stock is understood the growing material in an abnormous forest. [Thinnings are left out of consideration in regulating the working of a forest, because they cannot be fixed beforehand. They must be done when necessary. Besides, in a forest in which the final fellings are properly regulated, the thinnings are regulated of itself.] In the same way as the real growth in most natural forests is smaller than the normal growth, so is the real growing stock generally smaller than the normal growing stock.

18. At first sight it would appear that, in order to calculate the normal stock, the actual contents of the age classes of a

normal forests would have to be summed up,—an operation not without difficulty. But there is a point to be taken into consideration, which makes matters much more easy. The contents of each age class become only of importance when they reach the age of the rotation, that is to say, the year of their being cut and removed. Hence it is of no consequence what the contents of a certain age class may be at any time, provided the class contains the normal stock when it reaches the end of the rotation, in other words, the value of each age class should be calculated by its contents on reaching the end of the rotation, and before that time in inverse proportion of the number of years it is distant from that time. Hence the *contents of the different* age classes are estimated by means of the *average* annual growth, and not by means of the current annual growth. Thus the amount of the normal stock stands as follows, if under g the average annual growth of one age class, and under r the number of years in the rotation is understood.

Contents of the 1st age class (1 year old)	$= g.$
„ „ „ 2nd „ „	$= 2g.$
„ „ „ 3rd „ „	$= 3g.$
„ „ $(r-1)^{TH}$ age class	$= (r-1)\ g.$
„ „ r^{TH} „ „	$= r\ g.$

Consequently

$$\text{Normal stock} = n\,s = g + 2\,g + 3\,g + \dots + (r\text{-}1)\,g + r\,g.$$

$$n\,s = \frac{g+rg}{2} \times r.$$

$$n\,s = \frac{r.\ g}{2} + r \times \frac{r\ g}{2}.$$

r g means the contents of the oldest age class, which may be *represented* by G, then the above formula would be

$$n\,s = G. \times \frac{r}{2} + \frac{G.}{2}$$

19. The above calculation is for the time, when the youngest age class is 1 year old, and the oldest r years, that is to say, for the *end* of the growing season. The calculation for the beginning of the growing season stands as follows :—

Contents of 1st age class	$= 0$
„ „ 2nd „ „	$= 1$
„ „ 3rd „ „	$= 2$
„ „ $(r-1)^{TH}$ age class	$= (r-2)\ g$
„ r^{H} „ „	$= (r-1)\ g,$

and

$$n\,s = \left\{\frac{0 + (r-1)\,g}{2}\right\} \times r = (r-1)\,g \times \frac{r}{2}$$
$$n\,s = \frac{r}{2} \times r\,g - \frac{r\,g}{2}$$
$$n\,s = G \times \frac{r}{2} - \frac{G}{2}$$

20. Thirdly, the calculation may be made for the *middle* of the growing season, middle of summer, when the following will be the result:—

Contents of 1st age class	$= \frac{g}{2}$
" " 2nd " "	$= g + \frac{g}{2}$
" " 3rd " "	$= 2\,g + \frac{g}{2}$
" " $(r-1)^{TH}$ "	$= (r-2)\,g + \frac{g}{2}$
" " r^{TH} "	$= (r-1)\,g + \frac{g}{2}$

and

$$n\,s = \left\{\frac{\frac{g}{2} + (r-1)\,g + \frac{g}{2}}{2}\right\} \times r$$
$$n\,s = \left\{\frac{g}{2} + r\,g - g + \frac{g}{2}\right\}\frac{r}{2}$$
$$n\,s = r\,g \times \frac{r}{2}$$
$$n\,s = G \times \frac{r}{2}$$

This means that the normal stock, calculated for the middle of summer, is equal to the contents of the oldest age class multiplied by half the number of years in the rotation. Instead of being made up by, say, 100 age classes ranging from ½ year's growth up to 99½ year's growth, the normal stock can be composed of, say, 50 age classes, each of which is covered with forest 100 years old, or again it can be composed of 100 age classes, each of which contains 50 years' old growth, or by any other *modification, provided the* sum *total is* equal *to* $= G \times \frac{r}{2}$

21. These, then, are the fundamental conditions of the normal state.

SECTION 2.

Relation between normal stock, normal growth, and normal yield.

1. *Relation between growth and yield.*

22. As in a normal forest the oldest age class is cut annually, it follows that the normal yield is always equal to the

contents of the oldest age class. And again, as the oldest age class does not shoot out of the ground yearly, but is formed by as *many* current annual growths, as the rotation contains years, it is evident that the normal yield must be equal to the current annual *growths of all the* different age classes in a normal forest. And again, the normal yield must be equal to the sum of the average annual growths of all age classes, because their sum must be equal to the average annual growth *of the whole forest, which as a matter of course, is equal to the* normal yield.

2. *Relation between growth and growing Stock.*

23. In the same way as invested capital bears interest, so may it be said, approximately, that the annual growth represents the interest of the growing stock in a forest. By dividing with the growing stock=s into the growth of a year=g, and by multiplying with 100 we obtain $\frac{g}{s} \times 100 = p =$ the per cents indicating the rate of increase for that particular year. Supposing for a compartment of 50 years of age $s = 80$ and $g = 2$, *then* $\frac{g}{s} \times 100 = \frac{2}{80} \times 100 = 2{\cdot}5$, *which means*, that the percentage of increase of this compartment from the 50th to the 51st year is equal to 2·5.

24. The distribution of the annual growth during a rotation is peculiar, and it should be closer considered here. It will be remembered, that in a normal forest at the beginning of a rotation the *normal* growing stock must be present. This stock, with the growth on it, is removed during the rotation, and while this is being done, a new normal growing stock must be collected for the second rotation. The former may be called the "old growing stock"=s, and the latter the "new growing stock"=s', *and the present object is to show how* the average annual growth during a rotation is divided between the two. Let us understand under r the number of years in the rotation, and under g the average annual growth of one age class, then there will be annually a growth $= r \times g$. During the first year all growth will take place on the old stock s, as there is *no* new stock s' as yet. At the end of the first year the oldest age class is cleared, and whatever grows up

again on the area afterwards is not removed during the first rotation, but remains for the second rotation ; consequently during the second year only (r—1) g takes place on s, and g on s'. During the third year s gets (r—2) g, and s' gets 2 g, and so on. In the last year of the rotation s gets nothing, and s' gets r × g. In this manner the following table is obtained :—

Distribution of growth during the rotation.

In the year.	Portion belonging to old growing stock = s.	Portion belonging to new growing stock = s.[1]
1	r. g.	0
2	(r—1). g.	1·g.
3	(r—2). g.	2·g.
4	(r—3). g.	3·g.
.	.	.
.	.	.
.	.	.
.	.	.
r — 3	3·g.	(r—3) g.
r — 2	2·g.	(r—2) g.
r — 1	1·g.	(r—1) g.
r	0	r·g.

25. This table teaches the following most important lessons :

(*a.*)—The increase on the old stock is equal to that on the new stock.

$$\text{Increase on } s = (r\,g + 0)\,\tfrac{r}{2} = G \times \tfrac{r}{2}$$

$$\text{Increase on } s' = (o + r\,g)\,\tfrac{r}{2} = G \times \tfrac{r}{2}$$

(*b.*) The increase on the old stock, as well as that on the new stock, is equal to the normal growing stock ;

(*c.*) Consequently during one rotation the total growth is equal to twice the normal stock ; and

(*d.*) The total amount of material removed during one rotation is equal to twice the normal stock.

CHAPTER II.

How to lead an abnormous forest over into a normal forest.

26. This is the foremost object of a working plan. As there are three fundamental conditions of the normal state, it follows that the abnormous state may be the consequence of either of these three being wanting, or two, and even all three at the same time.

27.—1. *The normal age classes are missing,* whereas the normal growth and the normal stock are existing. To establish the normal age classes, different methods may be followed. The simplest of these is the *method of areas,* which means the whole forest is divided in as many parts as the rotation contains years or periods—during each year or period one part is cleared and restocked, and at the end of one rotation the normal age classes, together with the normal felling areas, have been established. In dividing the forest into felling areas, it must, however, be taken into consideration that the quality of the soil, and consequently *the quantity of material produced, differs* in every forest, and in determining the area to be cleared in each year or period, the relative quality of the soil must be taken into consideration,—a subject which will be considered in detail further on.

28. *The merits of this method are not of an high order. If* the normal age classes are very nearly established, the method does not do much harm, but otherwise it has the disadvantage of being two sweepings. In the first instance it takes no notice of the wishes of the owner of the forest, that is to say, if once adopted, it is *unyielding* and inelastic. Then it gives uneven annual yields during the first rotation. In one year the cutting may be in a compartment with only a fraction of the contents of that to be cleared the following year. Besides, it is liable to drag a surplus of growing stock over a whole rotation, whereas, if such does exist, it should be removed at once. It has been shown above that, in order to obtain the normal yield of a forest, it is necessary that the normal stock should be present. Now, it can happen that a forest, being stocked chiefly with old timber, may contain more than the normal stock, and that surplus does, of course, not produce any increased growth,

consequently it should be removed at once, and the money realized put out upon interest, if the forest is to yield the highest possible income to its owner. As this surplus stock is generally distributed over the forest, it naturally follows that, with the above method, only a portion of it is removed year after year; hence a pecuniary loss to the owner of the forest must be the consequence. In spite of these disadvantages the method of areas is very useful, whenever the object is to follow a simple system, which can be easily understood and carried out.

29. Another method is known as *the method of Carl Heyer*, which is this:—"If the normal stock and normal growth are existing, then the normal age classes will establish themselves naturally, provided the normal yield is cut annually or periodically in the oldest wood, and provided the cleared areas are immediately stocked again." In reality, the normal state is never quite reached, but already after three rotations the difference between it and the real state of the forest is so insignificant, that the difference may be neglected.

30. This method must be considered almost perfection, because any surplus over the normal stock can be removed at once, and the yield is the same in each year from the beginning up to eternity. Several mathematicians have tried to prove mathematically the correctness of Carl Heyer's method, but, as the truth can only be established by resorting to the highest branches of mathematics, we must be satisfied here with a practical example like the following:—

Assuming the

Rotation	=	5 years.
Area of forest	=	5 acres.
Average annual growth per acre	=	1 cubic foot.
Present age of forest, uniformly	=	$2\frac{1}{2}$ years.

Then there will be—

Normal yield	=	5 cubic feet.
Normal stock	=	$12\frac{1}{2}$,,
Real stock	=	$12\frac{1}{2}$,,

Consequently—

Normal stock	=	real stock.

As the age is given at $2\frac{1}{2}$ years, it follows, that it is given for the middle of summer. Assuming that all cuttings are done in winter, the age of the trees, when the first cutting takes place, will be three years. As 5 cubic feet have to be removed per year, the area x to be cleared is found by the following rule :—

$$\frac{\text{Real stock per acre}}{1} = \frac{\text{normal yield}}{x} \text{ or } \frac{3}{1} = \frac{5}{x}, \text{ and } x = \frac{5}{3}$$

$= 1{\cdot}6666667$. The remaining area for that year will be $5 - 1{\cdot}6666667 = 3{\cdot}3333333$. If the calculation is thus made for a number of years, the following table will be obtained :—

Year of Rotation.	Age of Forest when cut. Years.	Area to be cleared annually. Acres. In detail.	Area to be cleared annually. Acres. Total.	Balance of area of cutting compartment. Acres.	*Yield per year.* Cubic feet.
1.	2.	3.	4.	5.	6.
1	3	1·6666667	1·6666667	3·3333333	5
2	4	1·25	1·25	2·0833333	5
3	5	1·00	1·00	1·0833333	5
4	6	0·8333333	0·8333333	0·2500000	5
5	7 4	0·25 0·81250	1·06250	.... 0·8541667	1·750 3·250 } =5
6	5 4	0·8541667 0·1822916	1·0364583	.... 1·0677084	4·271 0·729 } =5
7	5	1·00	1·0000000	0·0677084	5
8	6 5	0·0677084 0·9181499	0·9864583	.... 0·0812501	0·406 4·594 } =5
9	6 5 4	0·0812501 0·8333333 0·0864582	1·00416	.... *0·9760418*	0·487 4·167 *0·346* } =5
10	5 4	0·9760418 0·0299480	1·0059898	.... 1·0065103	4·880 0·120 } =5
11	5	1·00	1·0000000	0·0065103	5
12	6 5	0·0065103 0·9921876	0·9986979	.... 0·0078124	0·039 4·961 } =5
13	6 5 4	0·0078124 0·9864583 0·0052085	0·9994792	.... 0·9958331	0·047 4·932 0 021 } =5
14	5 4	0·9958331 0·0052036	1·0010442	.... 1·0007812	4·979 0·021 } =5
15	5	1·00	1·0000000	0·0007812	5

The above table, and in particular column 4, shows, that by the end of the third rotation the normal state may be said to have been established.

31—2.—*The normal stock is missing*, whereas the normal age classes and the normal growth exist. Here two cases must be distinguished.

(*a*) *The real stock is smaller than the normal stock.*—If in this case the normal yield is removed annually, then the stock will be exhausted before the rotation is over, with other words, a lower rotation will be arrived at. In order to avoid this, it is necessary to remove less than the normal yield, so as to save stock, until the real stock has become equal to the normal stock. Now, this can be done in two different ways. It may have been decided that every year an equal quantity is to be saved, or the time during which the saving is to be completed has been fixed. In the former case, the time necessary to complete the saving is found by the formula time $a = \frac{ns - rs}{m}$, where m represents the quantity to be saved annually, and rs the real stock.

In the second case the amount to be saved annually is ascertained in the following manner :—

Saving $m = \frac{ns - rs}{a}$.

Example :—

If $ns = 5{,}000$ c′
$rs = 3{,}000$ c′ and
$m = 100$, then
$$a = \frac{5{,}000 - 3{,}000}{100} = \frac{2{,}000}{100} = 20 \text{ years};$$

or, if the normal stock is to be saved in 10 years
$$m = \frac{5{,}000 - 3{,}000}{10} = \frac{2{,}000}{10} = 200 \text{ c}'.$$

It must not be overlooked here that there is a limit to the size of m as well as of a, as not more can be saved per year than the growth during the year.

32—*b.*—*The real stock is greater than the normal stock.*—The consequence of removing in this case the normal yield will be a higher rotation, than fixed. To avoid this, it is necessary to remove the surplus stock. This again can be done, either at once, or distributed over a number of years. It will

depend on the state of the market, which of the two ways is to be adopted. If no considerable reduction of prices is the consequence of increased cuttings, then the surplus stock should be cut and sold at once, otherwise it will probably be preferable to bring it gradually into the market. Even with a moderate sinking of prices, it may be preferable to remove the surplus stock at once.

33. The effect of a surplus over the normal stock has been shortly mentioned above, but there are a few further points which should be noted. Such a surplus does not only not produce an additional income, but it may actually reduce it. The highest yield is obtained with a rotation equal to the year in which the average annual growth reaches its maximum. If a surplus stock leads to a higher rotation, then a lower average annual growth or yield, equivalent to a loss, will be the consequence. This refers to quantity ; but as certain classes of timber become more valuable per cubic foot with advancing age and size, it may pay the owner of a forest to work with a rotation higher than that of the maximum average annual growth, and which may be called the rotation of the maximum money yield. If the rotation is further raised, absolute loss of income must be the consequence, not only by keeping dead capital in the forest, but also by reducing the annual yield. Hence the great importance of ascertaining the normal stock, of removing any surplus over and above it, and of making up any deficiency by saving.

34.—3.—*The normal growth is missing,* whereas the normal stock and age classes are present.

(*a.*)—*The real growth is smaller than the normal growth.*— This will be the case, when there are blanks, or old and deceased trees, which do not increase, or if the quality of the soil has been reduced, for instance by jungle fires. If in this case the normal yield were removed annually, the normal stock would be encroached upon, resulting in a reduced rotation. Hence the yield must not surpass the real growth, and in the meantime blanks must be cultivated, old and deceased trees removed and replaced by young growth, or the quality of the soil improved, for instance by keeping out jungle fires.

35.—(*b.*)—*The real growth is greater than the normal growth.*—This will be a rare case, but it may occur, for instance if in consequence of improvements in the soil the actual result surpasses the estimate. In this case the yield must be equal to the real growth and not equal to the normal growth, or else a higher rotation will be the result.

36—4.—*Two or three of the fundamental conditions are missing at the same time.*—In that case it has to be considered which of the conditions is to be restored first. As a rule this will be the normal growth, and in fact in most cases it will be advisable to remove old material and even increase a deficit in the normal stock still further, for the sake of establishing as fast as possible the normal growth.

37. The formula for restoring the normal stock can be combined with the case, when the normal growth is also abnormous. Assuming that the real stock=r s is smaller than the normal stock n s, and the real growth=r g is smaller than the normal growth=n g, and that the time for establishing the normal state has been fixed at=a, then the real yield is $ry = rg + \frac{rs - ns}{a}$

Supposing

$$
\begin{aligned}
ns &= 5{,}000\ c' \\
rs &= 3{,}000\ c' \\
ny = ng &= 100\ c' \\
rg &= 75\ c' \\
\text{and}\quad a &= 50 \text{ years, then} \\
ry &= 75 + \frac{3{,}000 - 5{,}000}{50} = 75 - \frac{2000}{50} = 75 - 40\,; \\
ry &= 35 \text{ cubic feet.}
\end{aligned}
$$

38—5.—*Two or more forests belonging to the same owner are abnormous.*—In this case they may be thrown together into one working circle, or the provisions of the Working Plan for one forest may be arranged with reference to the provisions of that for the others.

CHAPTER III.

Reserve Stock.

39. After the management of a forest has been regulated so as to yield an annually equal return, it may happen that

circumstances prevent the yield being available. These may be natural phenomena, such as draught, inundations, jungle fires, or political events, as wars, &c.; then again too heavy cuttings, faulty estimation, etc. In such cases many owners desire to have reserves to fall back upon, and consequently the object of a reserve stock is to counteract disturbing events, and to prevent the normal state of the forest being interfered with. The effect of all such interferences is to reduce the normal stock, and consequently the best way of obviating it is to keep a somewhat higher normal stock, than is actually necessary, that is to say, to manage with a somewhat higher rotation, than has been fixed in the first instance. When then disturbing events occur, the surplus stock may be used up, thus reducing the rotation to the normal length. Afterwards the reserve stock may be established again by savings. The presence of a reserve stock will of course reduce the normal yield somewhat, but many owners of forests prefer a slight annual loss to an entire failure of income, whenever disturbing events happen. In well-regulated forests a reserve stock should be the rule, but if a large area of forest is in one hand, the reserve stock may be smaller or even given up altogether, as then the disturbing influences generally compensate each other.

40. The size of the reserve stock depends on the will of the owner, who will be guided by the greater or lesser probability and the nature of disturbing events.

The Forests and Flora of the Tinnevelly District.

By Lieut.-Colonel R. H. BEDDOME,

Conservator of Forests, Madras.

THE chain of ghâts which lie between the Tinnevelly District and Travancore are exceedingly interesting both to the Forester and Botanist, as they abound with valuable timbers and new and rare plants; they rise in several places to over 5,000 feet. About the base on the Tinnevelly side the climate is often very dry, and the vegetation is somewhat stunted or consists of light deciduous forests as the S. W. Monsoon seldom reaches the base of the mountains; but as the ghâts are

ascended, heavy evergreen forests are everywhere met with, or dense tracts of the Irul called elephant grass (*Beesha travancorica*), a grand species of Bamboo which does not occur north of the Tinnevelly District, patches of real grass land are few and far between. These evergreen forests generally get the full force of the S. W. Monsoon as well as heavy showers during the N. E. Monsoon, so that they are exceedingly damp during the greater portion of the year, and seldom very dry during the cold and hot seasons, as rain often falls during the months of January and February as in Ceylon, and heavy showers during April and May. Some portions of these evergreen forests (as some of the tracts above Sivagiri to the north and above Kalcad to the south) seem, however, to be almost beyond the influence of the S. W. Monsoon, and they are often very dry during June, July, and August.

Until the Forest Department commenced operations in the District only some few years ago, the forests were quite unexplored. Some of the early missionary botanists and Dr. Wight botanized and collected in the immediate vicinity of Courtallam, and the latter gentleman named and figured in his "Icones" many new plants collected in that neighbourhood and about Sivagiri, but the tracts to the south of Courtallam were never visited. Since conservancy commenced, the Conservator of Forests has visited most portions of the ghâts, and he has named and figured many new trees and plants in the "Flora Sylvatica" and the "Icones Plantarum," but each trip he makes, new trees and plants are found, and, as large tracts are still unvisited, there is probably very much to be discovered and a wide field for the botanist.

The forests partake much of the character of the ghât forests in Malabar and on the Anamullays, the greater number of trees and plants being the same. Numerous species, however, exist which have not been found further north, and a good sprinkling only before known to grow in Ceylon, such as *Mischodon Zeylanicus*, a fine timber tree (*Euphorbiaceæ*); *Xylopia parviflora* (a lofty Anonacious tree); *Trichopodium Zeylanicum*, a Discoreaceous plant, *Trigonostemon nemoralis*, (a Euphorbiaceous plant); and *Weihia Zeylanica* (*Rhizophoracea*), &c.

The dense tracts of the *Beesha travancorica*, which cover thousands of acres often to the exclusion of all other vegetation, are quite characteristic of these mountains, and nothing like them are met with further north. These tracts are often so dense as to be quite impenetrable even to the wild elephants.

The occurrence of *Podocarpus latifolia*, the only coniferous tree found in Southern India, is a very interesting fact; as, although it grows in some portions of the Himalaya, it has never been detected in any of the ghât forests from Bombay down to Tinnevelly or in Ceylon, and being a most striking tree, it could hardly have escaped detection. This tree is most abundant in some of the Tinnevelly forests at 2,000 or 4,000 feet elevation.

The occurrence of a beautiful species of *Cypripedium* or Slipper Orchid is also of great interest, as the genus does not occur elsewhere in the Peninsula or in Ceylon.

The orders of the vegetable kingdom chiefly represented in these heavy forests are as follows:—*Anonaceæ*, amongst which are species of *Gomothalamus*, *Xylopia*, *Orophea*, and *Meliusia* not occurring further north; *Guttiferæ* with *Garcinia travancorica*, *Wightii?* and a third undescribed species, and *Poeciloneuron pauciflorum* not found elsewhere; *G. travancorica* is gregarious, and in some tracts between 4,000 and 5,000 feet elevation forms about 50 per cent. of the vegetation; *Dipterocarpeæ*, with two species of *Balanocarpus* (a new genus which also I believe occurs in Borneo); and two or three *Hopeas* not found elsewhere; *Meliaceæ* with a species of *Dysoxglon* and one of *Agalia* not occurring elewhere; *Anacardiaceæ* with a lately described species of *Gluta*, two species of *Semecarpus*, and two of *Nothopegia* only found on these mountains. *Leguminosæ*, amongst which are an *Ormosia*, *Cynometra travancorica*, *Hardwickia pinnata*, *Humboldtia unijuga* and two undescribed species, and *Calliandra cynometroides* not met with elsewhere. *Myrtaceæ*, with several lately described species of *Eugenia* only found on these mountains. *Rubiaceæ*, with *Acranthera grandiflora*, *Byrsophyllum tetrandrum*, two species of *Saprosma*, two of *Lasianthus*, several of *Hedyotis* and of *Plectronia* and of one *Octotropis* only lately discovered here. *Sapotaceæ* with

an undescribed species of *Dichopsis*. *Ebenaceæ* with *Diospyros foliolosa* peculiar to this range. *Styraceæ* with *Symplocos oligandra* only met with here. *Acanthaceæ* with two very fine plants of the new genus *Diotacanthus*. *Myristicaceæ* with *Myristica magnifica* peculiar to these hills. *Lauraceæ*, *Euphorbiaceæ* with *Mallotus distans* an undescribed *Trigonostemon* and *Cœlodepas calycina* not found elsewhere. *Urticeæ* and *Filices*. Of other remarkable plants amongst orders not abundantly represented may be mentioned the following:—*Acrotrema Arnothianum* (in *Dilleniaceæ*), *Sterculia alata* and *Heritiera papilio* (in *Sterculiaceæ*), *Parinarium travancoricum* (in *Rosaceæ*), *Homalium travancoricum* (in *Samydaceæ*), *Begonia floccosa* and several other species peculiar to these mountains (in *Begoniaceæ*), *Exacum travancoricum* (in *Gentianeæ*), *Didymocarpus repens* and several other species described by Dr. Wight (in *Gesneraceæ*), *Helicia robusta* (in *Proteaceæ*); nor must the beautiful balsams be excluded from special mention. *Impatiens grandis* and *umbellata* (Heyne) and *uncinata* (Wight) being all very beautiful plants peculiar to these ghâts, and *viridiflora* and *auriculata* (Wight) most curious *epiptytia* species.

Teak is met with at the base of the mountains in several places, but always beyond the full influence of the S. W. Monsoon, and it is of very poor growth and hardly worthy of being entered as one of the timbers of the district, but the mountains produce many valuable timbers and, what is not the case elsewhere on our Western Ghâts, many of the most valuable timbers are peculiar to the heavy evergreen forests, amongst which may be particularly mentioned three species of *Mesua* (called *Nang*), the *Hopeas* and *Balanocarpus* (called *Kong*), *Poeciloneuron pauciflorum*, *Heritiera Papilio*, *Pterospermum rubiginiosum*, *Gluta tarvancorica*, *Ormosia travancorica*, *Hardwickia pinnata*, *Hemicyclia elata* and *Gironniera reticulata*.

The following may be enumerated as the most valuable timbers as yet known in the district:—

Mesua, three species, (called Nang).
Poeciloneuron pauciflorum (called Podungoli).
Hopea, several sp. (called Kong).

Balanocarpus, two species (called Kong).
Heritiera papilio.
Pterospermum rubiginosum.
Grewia tilioefolia.
Chickrassia tabularis,
Cedrela Toona.
Chloroxylon Swietenia.
Schleichera trijuga.
Gluta travancorica.
Ougeinia dalbergioides.
Ormosia travancorica.
Pterocarpus marsupium.
Hardickia pinnata.
Acrocarpus fraxinifolia.
Xylia dolabriformis.
Prosopis spicigera.
Acacia sundra.
Albizzia, several sp.
Terminalia, several sp.
Eugenia, several sp.
Homalium zeylanicum.
Lagerstrœmia reginœ.
„ *microcarpa.*
Hymenodictyon obovatum.
Diospyros ebenum.
Stereospermum suaveolens.
Gmelina arborea.
Vitex altissima.
Phyllanthus emblica.
Bischoffia javanica.
Hemicyclia elata.
Briedelia retusa.
Gironniera reticulata.
Artocarpus hirsuta.
„ integrifolia.

Some of these timbers are scarcely known as yet except to the natives, and it is very probable that there are many valuable timbers quite unknown.

Gums, resins, dyes, fibres and such like hill products have as yet received little or no attention, but they will undoubtedly some day yield a fine revenue, as these forests are particularly rich in all these products. It may be here mentioned that the *Hardwickia pinnata* is known to yield a valuable balsam or oleoresin which could effectually substitute Copaiva balsam. The resin yielded by *Ailanthus Malabarica* might also substitute Venice turpentine, but it is always much adulterated by the people who collect it. The *Dichopsis elliptica* (formerly known as *Bassia* or *Isonandra*) yields a kind of gutta which may prove of value, and a second species of *Dichopsis* has just been discovered. The fruit of the different species of *Semecarpus* which abound on these hills yield a valuable black dye. The *Mallotus Philippinensis*, the powder from the capsules of which yield a valuable red dye, is most abundant, and Myrobolans (*Terminalia chebula*), a valuable article of commerce, are very abundant. There are two species of wild plantain, very plentiful, from which valuable fibres might be extracted, and cardamoms, ginger, and turmeric are abundant.

It is much to be regretted that a very considerable portion of these ghât forests belong to Zemindars, or are the property of temples. Above Paupanassam an enormous tract which protects the principal sources of the Tambrapurny river, belongs to the Singumputty Zemindar (at present a minor). It is more than probable that before long (unless the State can interfere) the forest will give way to Coffee plantations; the result would be considerable injury to the cultivation along the river, as excessive floods at some seasons and dearth of water at others would certainly follow the deforestment of these mountains.

Juniper Fungi.

By M. C. Cooke, M.A., LL.D., A.L.S.

It will be admitted by all who have paid attention to the growth of Junipers in temperate countries, that they are very subject to the attacks of certain peculiar parasitic fungi, which causes the branches to swell to twice their original diameter, throughout a length of from one or two to six or eight inches.

These gouty swellings in spring or summer become from year to year perforated by yellow or orange gelatinous masses, usually with a more or less club shape, and from a quarter of an inch to an inch or more in length. These tremelloid masses externally and superficially bear considerable resemblance to some species of *Tremella*, but the internal structure, as revealed by the microscope, is of a totally different character from that which prevails in the genus *Tremella*, and its more immediate associates. The spores, or protospores, for the latter is the more accurate designation, resemble those of the brands, or genus *Puccinia*, and it is in intimate relationship with this latter genus that the Juniper parasites are classified by mycologists, under the two generic names of *Podisoma* and *Gymnosporangium*.

Not only are these fungi found on Junipers over the greater part of Europe, but they are equally and perhaps even more abundant in North America; and although not specially recorded in India, there is every reason to suppose that the Himalayan region will not be destitute of such a persistent companion of the Juniper, of nearly every species, in other countries. It is very certain that *Juniperus communis* is attacked freely enough in Europe by more than one species of parasite of this kind, and no sound reason can be alleged against similar attacks in the North-West. Nor is it in the slightest degree improbable that *Juniperus excelsa* or *J. recurva*, especially the latter, may be affected in a similar manner. It would at any rate be interesting to ascertain the fact, if it should prove to be a fact, that all the Himalayan Junipers are free from the almost universal "Juniper pests."

As to the fungus itself undoubtedly it is deeply seated in the plant, and develops outwardly year by year, by the protrusion of gelatinous tongues through holes and fissures of the bark, which "tongues" are masses of the fructification of the parasite. If we take a portion of the orange substance which constitutes the exposed portion of the fungus, and place it in a drop of water under the microscope, we shall observe that it consists of a multitude of brown bilocular spores, or bodies resembling spores, with very long transparent peduncles. These

bodies are immersed in a kind of gelatinous medium which holds them together in the tongue-like or club-shaped forms already alluded to. In dry weather, or after a summer heat in cool latitudes, the protruded masses are soon dried up, and *then only the gouty swellings attest the presence of the* disease.

In 1848 M. Gasparrini first hinted that the bilocular spores of these fungi did not deserve the unqualified designation, and in 1853 M. Tulasne illustrated their true character. These pretended spores are formed of two large conical cells, opposed by their base, and easily separating. They vary in length from ·06 to ·08 m. m., and ·015 to ·019 m. m. in width in the ***Podisoma** juniperi-communis.*

The membrane of which they are formed is thin, and completely colourless in most of the individuals, though much thicker, and coloured brown in others. It is principally the spores with thin membranes which emit from near the middle very obtuse tubes, having a diameter of from ·007 to ·01 of a millemetre, and into which by degrees as they elongate the contents of the parent utricles pass. Each of the two cells of the supposed spore may originate near its base four of these tubes, opposed to each other at their point of origin, and their subsequent direction; but it is rather rare for eight tubes (two by two) to decussate from the same spore. Usually, there are only two or three which are completely developed, and these tend together towards the surface of the fungus, which they pass and expand at liberty in the air. The tubes generally become thicker by degrees as they elongate, some only slightly exceeding the length of the protospores; others attain three or four times that length, according to the greater or less distance between the protospore and the surface of the plant. In the longest tubes it is easy to observe how the colouring matter (endochrome) passes to their outer extremity, leaving the portion nearest to the parent cell colourless and lifeless. When nearly attaining their ultimate dimensions, all the tubes are divided towards their outer extremity by transverse septa into unequal cells; then simple and solitary processes of variable length and form, but attenuated upwards, proceed from each

segment of the initial tube, and produce at their extremity an oral spore (*teleutospore*), which is slightly curved and one-celled. These spores absorb all the orange endochrome from the original tubes, and measure ·01 to ·013 m. m. in length. They appear in immense numbers on the surface of the fungus, and when detached from their spicules fall upon the ground, or on any object which may be beneath them in the same manner as the spores of an Agaric are dispersed. So freely are they deposited that they may be collected on paper or on a slip of glass like a fine gold-coloured powder. These latter bodies, M. Tulasne states, evidently represent the ultimate stage and normal development of the protospores, or bilocular spore-bodies of the *Podisoma*, and these alone deserve the name of spores.

Although not specially required for the purpose of this communication, it may be of interest to state the ultimate history of the teleutospores which result from the germination of the protospores. These bodies are also capable of germination; for many of them will germinate on the surface of the *Podisoma* whence they originate. The germ filament habitually springs from the side, at a short distance from the hilum which indicates the point of attachment to the original spicule. These filaments will attain to from fifteen or twenty times the diameter of the spore in length before branching, and are in themselves exceedingly delicate.

The whole process of germination resembles that which prevails in the *Pucciniæi* and other *Uredines*, and indicates an affinity with such genera as *Puccinia* and *Triphragmium*.

Having thus indicated the salient points in the structure of these fungi, it will be necessary to advert to the different species which are known, and thus assist in the determination of any Indian forms which may hereafter be discovered.

COMMON JUNIPER PODISOMA.—The *Podisoma juniperi-communis* of Fries is common enough in Britain on Juniper bushes in the spring. The branches on which it occurs are swollen at the infected spot to nearly double their normal size, and the orange gelatinous masses of the fungus are protruded through holes and fissures of the bark in the form of spines. As winter

approaches all external manifestations, except the gouty swellings, disappear, and reappear again the following spring, *for many successive years. As a matter of course, the* foster plant becomes stunted and enfeebled, and its energies exhausted by this repeated parasitism; and although some authors have stated that the *Podisoma* is found growing on dead or dying branches, such is not the fact, as it will not *flourish on dead wood, but always appears on trees and branches* which are vigorous and full of life. The protospores in this species are lanceolate, uniseptate, and constricted at the septum. The teleutospores are obovate or pyriform. It occurs throughout Northern Europe, and in the United States of North America, is found also on the cedar (*Juniperus Virginiana.*)

SAVIN PODISOMA.—*Podisoma fuscum* of Duby occurs in Britain and other parts of Europe on the Savin (*Juniperus Sabinæ*). Tulasne collected it in Provence on *Pinus halepensis*, and on *Juniperus oxycedrus*. In the United States of America it is found sometimes on the branches of *Juniperus Virginiana*, causing globose swellings which are known as "cedar balls," in the same manner as in another closely-allied species. The gelatinous masses which are protruded through the fissured bark are of a more or less club-shape, of a darker red brown colour, with much darker protospores. The latter are also of a different shape, being elliptical, narrowed at each extremity, uniseptate, slightly constricted at the septum. The teleutospores are elliptical or sub-cymbœform.

VIRGINIAN PODISOMA.—The *Podisoma macropus* of Schweinitz is probably confined at present, at least as far as our knowledge goes, to North America. It is the most common species in the United States on *Juniperus Virginiana*, the most unfortunate of all the Junipers, since it supports three or four different and distinct parasites of this family. This *Podisoma* grows on the branches and slender twigs which form abnormal tufts on the cedar. On the branches excrescences are formed which resemble galls, and these are called cedar apples. The surface is generally marked with small depressions, from which at certain periods there projects a small point varying in length. This process consists entirely of the gelatinous fungus. When

wet they absorb moisture very rapidly, swell, and become much elongated. In the cedar apple they often project to the distance of one inch, and hang down like tassels. In localities where the Juniper is abundant, these excrescences exist in large quantities, so that after rain the trees have the appearance of putting forth large numbers of flowers, in consequence of the sudden elongation of these collections of fungi. Schweinitz remarks that the cedar apple always precedes the external manifestations of the fungus, swelling and increasing into a more or less turbinate head, which is traversed by the branch, and attains a diameter of one or two inches. When flourishing he says that it is easily cut and eaten like an apple, and becomes hard when dried. Externally there is an epidermis-like bark, of a purplish brown or lilac tint, and altogether juiceless, like the peel of an apple. The whole surface is regularly dotted with polygonal, usually pentagonal, foveola, which are at first plain, but presently dimpled and umbonate; at length, the bark being ruptured in the centre, the ligulate tremelloid masses burst forth in moist weather about an inch in length, of the most beautiful orange colour, adorning in the course of a single night the whole tree, as it were with the richest crop of ripe oranges. If wet weather continues for many days, it remains in this state till the ligules melt away. Under the influence of the sun, however, they soon dry up, and do not revive. The protospores in this species are shorter than those of the common Juniper, and longer than in the Savin Podisoma. The orange strap-like masses are double the length of those of *Podisoma fuscum* on the same species of Juniper.

GASPARRINI'S PODISOMA, which he also calls by the same name of *Podisoma fuscum*, is quite different from the species described by Duby under the same name. The Juniper which was attacked by this parasite was *Juniperus Phœnicia*, and Italy at present seems to be the only locality in which it has been found. There is still some mystery about this parasite, whether from imperfect or inaccurate description, or from any other cause, cannot yet be determined, but all information regarding it is confined to the single observations of Professor Gasparrini.

Juniper leaf Podisoma.—A species of *Podisoma* is found in Denmark which confines itself to the leaves of *Juniperus.* This was examined by Œrsted, and he arrived at the conclusion that, whilst it was the *Podisoma minor* of Corda, it was not different in its structure from *Podisoma juniperus-communis*, but was smaller, and only developed on the leaves. It is by no means the same as the *Podisoma foliicolum* of Berkeley, which in reality is not a *Podisoma* at all.

Tuberculate Podisoma.—The *Podisoma gymnosporangium* of Bonorden, which some botanists place in another genus, under the name of *Gymnosporangium juniperi*, Fries, is also common in Europe, and has been found in the United States. The branches of the host are not swollen to the extent in which they are swollen in the *Common Juniper Podisoma*, and the masses of the fungus are broad, tuberculate, and quite different in external habit and appearance. The protospores are short, elliptic, divided in the centre into two equal obtusely triangular cells. It inhabits *Juniperus-communis.*

Club-stemmed Podisoma.—A closely-allied species, it may be only a variety of the last, is found in the United States of America, growing on branches of *Juniperus Virginiana.* The external masses of the fungus are smaller, but of a similarly expanded form, and the protospores are alike in colour, form, and size, but the hyaline peduncles are very much thicker and swollen in a clavate manner until they become as broad as the protospore. This is such a marked and decided difference that the name of *Podisoma clavipes*, or rather of *Gymnosporium clavipes* has been applied to it. The fructification of all these species was figured in a communication published in the journal of the Quekett Microscopical Club of London in the year 1871.

Biseptate Cyprus Podisoma.—*Podisoma biseptatum*, or as it has been called *Gymnosporangium biseptatum* is one of two species found on *Cupressus thyoides*, and at present confined to the New World. In both these species the pseudospores are long and biseptate. The present species swells the branches considerably on which it is parasitic, and the fungus masses of a chestnut colour, as large as peas, protrude in very irregular but compressed forms. Like other species the gelatinous expan-

sions appear every year from the same gouty swellings, for several years, and gradually these swellings increase until the branch is more than double its original dimensions.

Ellis's Podisoma.—*Podisoma Ellisii* was described and figured in the *Gardener's Chronicle.* It occurs also on *Cupressus thyoides* in North America, and is the other species above alluded to with biseptate pseudospores. The fungus masses are elongated and quite different in form from those of the last named species. Until these two were discovered a few years since, it was believed that all the species had biseptate protospores. As the germination had not been observed, the form of the teleutospores is at present unknown. From these brief notices it will be possible to identify any which may be encountered in the Himalayan region.

In the life history of these fungi there is one peculiar circumstance which can scarcely be passed over, even in a communication of this description, and this is their supposed polymorphism. Of late years the Brothers Tulasne, and others, have directed attention to the occurrence of what is practically the same fungus under different phases, which had previously been regarded as distinct and autonomous fungi. It is principally to Professor Œrsted, of Copenhagen, that we are indebted for investigations into the relationships of *Podisoma.* This learned author maintains that certain other fungi belonging to the genus *Ræstelia* are but a stage in the life history of *Podisoma.* He contends that the *Ræstelia* of the pear tree, the *Ræstelia cancellata* is one generation of *Podisoma fuscum,* that the Hawthorn fungus *Ræstelia lacerata* is but one form of *Podisoma juniperi-communis,* and that the *Ræstelia,* which flourishes on the mountain ash and some other plants and called *Ræstelia cornuta,* is intimately related to *Podisoma gymnosporangium.* If these assumptions are correct, then the species of *Ræstelia* should be found in all countries which contain the *Podisoma.* As we have no record of the occurrence of *Podisoma* in India, so also we have no record of the presence of any species of *Ræstelia.* The grounds on which Professor Œrsted maintains his theory are these, that he has sown the teleutospores of the *Podisoma* on young healthy plants of the

Sorbus, and that, as a result he obtained the parasite *Ræstelia cornuta.* The spores of the *Ræstelia* were also sown on young shoots of the Juniper, but the successful production by this means of the *Podisoma* was never secured. Experiments of this kind are always open to the same objection, by the sowing of certain spores upon *Sorbus* after a time a parasite appears, but this parasite is the natural one to which the *Sorbus* is always subject, what evidence can be given that the parasite was truly the result of the sowing, and that the germs were not latent in the *Sorbus*, and would have been developed even had not the sowing taken place. The failure to induce the *Podisoma* to develop itself on the Juniper after sowing the spores of *Ræstelia* upon it, is another circumstance of suspicion. Clearly, it requires stronger evidence to support the belief that the sowing of the spores of any given fungus upon a specific plant will produce a parasite of entirely different structure and affinity, than would be required to substantiate the fact that the sowing of spores resulted in the production of a plant precisely like the parent stock.

Allusion has already been made to a parasite on the leaves of the Savin (*Juniperus Sabinæ*), which has occurred in Britain and Germany to which the name of *Sarcostroma Berkeleyi* is now applied. It makes its appearance in spring on the living leaves, as small sub-elliptic pitchy black excrescences, not larger than the head of a pin. Internally, it consists of a rather gelatinous stroma, from which radiate long hyaline peduncles surmounted each by an elliptical or fusiform spore of a dull brown colour when mature, and divided by three, rarely five, transverse septa. The spores do not adhere with any tenacity to each other, and do not appear to be involved in gelatine at all. It is also stated that the same fungus has been found in Europe on the leaves of *Juniperus-communis.* Probably, such a fungus would prove injurious, and even destructive to Junipers if sufficiently common, but hitherto its appearance has been so scanty that it can scarce be regarded as injurious to any thing like the same extent as the species of *Podisoma.*

A large number of other fungi occur on the various species of Juniper, but these are of no interest to the forester, as they

establish themselves on dead leaves, twigs, bark, &c., and not on any parts of the living plants. More or less all fungi which inhabit or attack growing plants are injurious to their host, although that injury is sometimes inappreciable unless excessively developed. Other *Coniferæ* have their own special kind of foes, and to these we must address ourselves in a subsequent communication. Any specimens of Junipers injured in the manner we have described, if forwarded in duplicate to Dr. Brandis, will be disposed of by retaining one specimen in the Forest Department for future reference, the other will be sent to England to be reported upon by the writer of this note.

INDIA MUSEUM, *London, June 8th*, 1877.

Report on the Preparation of Bamboo Fibre for Paper Making.

BY A. SMYTHIES,

Assistant Conservator of Forests, Central Provinces.

THE operations were commenced at Moharli on the 31st August. The machine used for crushing the young stems was an ordinary country sugar mill, with upright rollers, worked by two pairs of bullocks, and for boiling the crushed stems, a couple of the circular pans used for the evaporation of the sugar-cane juice were set up. These pans were about 6 feet in diameter, and 18 inches deep. Previous to crushing the bamboos, all the sheaths were removed, the stems cut up into convenient lengths, the thicker pieces split into two, and the soft white portion at the top of the stem thrown aside. Indeed, it was found necessary to cut away the lower parts of each of the 4 or 5 top internodes (that part which is surrounded by the sheath), it being too brittle to pass through the mill. The stems thus cut up and prepared, were then carefully weighed and passed through the mill. In order to express the sap to what was considered a sufficient extent, it was necessary to pass the lower and harder portions of the stems 5 times through the mill, while for the top parts 3 times was found to be enough. The stalks of the sugar-cane are generally passed through the mill two or three times.

The crushed stems were then subjected to 5 or 6 hours' hard-boiling in the pans. A certain portion of them was boiled in pure water, while another lot was boiled in an alkaline solution made by dissolving the crude soda of the bazars in the water; no definite proportion of soda was added, but the ley was of such a strength that it immediately turned the white fibre of the bamboo a dark yellow. The soda-boiled fibre was subsequently washed in clean water. A small quantity of crushed stems was dried as it left the mill, without being boiled at all. Thus three distinct samples have been prepared and kept separate one from the other, and their respective weights are as follows:—

			lbs.
A. Fibre boiled in pure water	...	...	340
B. and C. Alkaline ley	...	...	262
D. Fibre unboiled	...	...	198

The total weight of fibre prepared thus amounts to 800 lbs. The number and weight of green stems that yielded this are shown in what follows:—

The total number of bamboos of various sizes used up, was 2,485; of these about 400 averaged 12 feet in length, and the remainder varied from 6 feet to 7 feet. Their average girth at the base was 5 inches. Their total weight, neglecting of course the soft parts removed previously to crushing, amounted to 6,591 lbs. From this it is necessary to deduct 21 lbs. as the weight of the little chips and pieces that broke off in the mill. This leaves us 6,570 lbs. as the gross weight that resulted in 800 lbs. of dried fibre. These figures are not quite in accordance with those given by Mr. Routledge. In one of his papers on the subject he remarks that 40 tons green stems result in 10 tons dried, and 10 tons dried yield 6 tons of unbleached fibrous paper stock. That is to say, his yield is 15 per cent., whereas the above figures only give 12 per cent., and it must be remembered that the unboiled fibre will be still further reduced in weight by boiling in an alkaline ley. Moreover, the fibre which was boiled, whether in water or in alkaline ley, is evidently in a less-prepared state than the specimen of "paper stock unbleached" that was sent down to Moharli

for comparison; and it is more than probable that its weight also will be reduced by further treatment. Supposing then *that my figures* are correct, and *I* have every reason to *believe* them so, we cannot look for a yield of more than 10 per cent., when the fibre has been converted into unbleached fibrous paper stock.

The cost at which the 800 lbs. of fibre was turned out, stands as *follows* :—

		Rs.	As.	P.
1.	Cutting and carriage of bamboos ...	6	4	0
2.	Erection and working of mill ...	22	1	9
3.	Boiling crushed stems	13	12	6
4.	Drying the boiled and unboiled fibre ..	6	7	6
	Total Rs. ...	48	9	9

Item No. 3 includes Rs. 2 for crude soda, Rs. 2-8 as hire of boiling pans, carriage of fuel, and erection of boiling shed; but neither the value of the bamboo in the forest, nor the value of the fuel are included in the total.

It is scarcely fair to calculate from the above figures the cost at which a ton of crushed, boiled, and dried material can be turned out, nor is it of much practical use, as working on a large scale with proper appliances would greatly reduce the expenditure; but the calculation has been called for, and I now proceed to give it. Taking only the working expenses, *i.e.*, leaving out of consideration all preliminary expenses, such as erection of mill and boiling shed, hire of pans, &c., and omitting the soda we have :—

	Rs.	As.	P.
Cutting and carriage of bamboos ...	17	8	0
Crushing in the mill	50	0	0
Boiling	22	8	0
Drying the boiled fibre	18	0	0
Total Rs. ...	108	0	0

The number of bamboos required to yield this ton of boiled fibre will be 7,000. It has already been stated that their average length is 6 or 7 feet. If they were taken about 12 feet long,

I estimate that 4,500 only would be required, this calculation being made from the accompanying table which shows the actual weight of the different sizes of bamboos employed in the experiment:—

Average Length	Number of Bamboos.	Total Weight.	Average Weight p. 100 Bamboos.
Feet 12	416	1,696 lbs.	408 lbs.
„ 7	366	1,100 „	301 „
„ 6½	308	833 „	270 „
„ 6	1,395	2,962 „	212 „
Total ...	2,485	6,591 „	......

The present value in Moharli forest of bamboos is Re. 1 per 100, and taking the lower figure of 4,500, average length 12 feet, their value amounts to Rs. 45. This brings up the cost of a ton of fibre prepared at Moharli to Rs. 150, allowing nothing for supervision. It should be remembered that boiled fibre is in a far more advanced state than the crushed stems, which have been merely dried, and there is little doubt, that its price in the market would be proportionately higher.

That the total cost given for the preparation of the fibre, *viz.* Rs. 108, is fairly correct, will be gathered from the following considerations:—

1*st.*—*Cutting and carriage.*—4,500 bamboos, 12 feet long, will require 45 carts. Each cart will not be able to bring more than 2 *loads* a day from an average distance of 2 miles, and each cart will require 2 men to cut and collect the bamboos.

		Rs.	As.	P.
Hence, 22½ carts at 8 annas per diem	...	11	4	0
„ 45 men at 2 annas „	...	5	10	0
Total Rs.	...	16	14	0

2nd.—Preparation of bamboos and crushing in the mill.—The experiment proved that one mill can crush (5 times over) 700 lbs. weight in the day of 12 hours, hence to crush the weigh requisite to yield one ton of fibre will need 26 days.

	Rs.	As.	P.
Hire of bullocks for 26 days ...	26	0	0
4 men to work the mill at 2 annas each per diem	13	0	0
2 men to cut up and prepare bamboos ...	6	8	0
Total Rs. ...	45	8	0

3rd.—Boiling the fibre.—The experiment proved that the amount of fibre turned out in the day could be boiled in 3 of the ordinary pans during the day, *i.e.*, one pan boiling twice for 5 or 6 hours at a time, and the other once. To superintend the boiling, to cut up wood, and to bring water, &c., requires 5 men a day, and one cart-load of fuel is consumed in the day.

	Rs.	As.	P.
Hence, 5 men at 2 annas per day, 26 days	16	4	0
Carriage of 26 cart-loads of wood at 3 cart-loads (for 8 annas) a day ...	4	5	0
Total Rs. ...	20	9	0

4th.—Drying and packing the fibre.—The cost of drying depends entirely on the weather. But it may be estimated that to spread out and dry the amount of fibre that comes from the 3 pans in the day, and to pack it away as dried, requires 4 men and 2 boys.

	Rs.	As.	P.
4 men at 2 annas, and 2 boys at $1\frac{1}{2}$ annas per diem, for 26 boys	17	14	0
Thus the total cost at these rates would amount to Rs.	100	13	0

The figures given in the foregoing statement were obtained by multiplying the actual working cost of turning out 800 lbs. of

fibre by 2·8, as 800 lbs. is the $\frac{1}{2\cdot8}$ part of a ton. The close correspondence between the two proves that Rs. 100 may safely be taken as the cost of turning out a ton of fibre, in the same manner and under the same conditions as in the experiment which was conducted at Moharli.*

* These data prove exactly what we have foretold (officially), namely, that the price likely to be offered for bamboo paper stock by manufacturers is far too low to make the preparation of the stock remunerative.—THE EDITOR.

III.—NOTES AND QUERIES.

Brief Account of the Royal Forest School at Vallombrosa.

By HUGH CLEGHORN, M.D., *Stravithie, St. Andrews.*

ITALY, like other lands bordering the Mediterranean, has suffered from wasteful denudation of her formerly wooded tracts, to the detriment of the climate, to the poverty of the country, and to the marring of her beauty. But she is in advance of the adjoining countries of southern Europe, in having set herself to the task of repairing the damage done in previous centuries. The woodlands have long been looked upon by the people as common property, in which they were free to pasture their herds, and from which they might help themselves to wood *ad libitum*. Laws have now been enacted to compel, under penalty, the replanting of communal woods, and a code of forest laws is being prepared by the senate. To render these thoroughly effective, they must be applicable to private as well as to state forests, and for the administration of these laws throughout the kingdom, officers are being trained at the Royal Forest School of Vallombrosa, near Florence, an institution which promises to be successful in its work. A short account of its history, and of a visit paid to it, may prove interesting.

On the 14th May 1875, I left the Hotel de l'Europe, Florence, after early breakfast, and proceeded by the Arezzo Railway as far as Pontassieve, which is reached in an hour. Here I engaged a light one-horse vehicle (*biroccino*) for fourteen lires to Paterno and back. The driver was a pleasant companion, a good-humoured rustic, familiar with the surrounding country, who pointed out the localities of the district, and received a friendly greeting from all the cottagers we passed. The smooth, well-constructed road led upwards by a series of easy zigzags; dense cypress avenues were seen near the villas, and many rows of mulberry trees fringed the fertile fields; much cultivated for fodder is lupinello (*Onobrychis sativa*); and also a blue Iris,

with a fragrant root. In waste ground two showy species of Genista were in flower. At every turn of the road, extensive views of the valley of the Arno lay below us. The vineyards and orchards exhibited a high degree of cultivation.

At the old castle of Paterno, a young forest officer, Alberto Helguero, informed me that the director, Cavalier Adolfo di Bérenger, had been expecting me for two days, and that a posted mule had just been recalled. After hospitably entertaining me at luncheon, which consisted of wine, cheese, and bread, he procured for me a two-wheeled country cart, drawn by two large white bullocks, and passing through the village of Tosi, I soon reached a paved roadway *(viâ crucis)*, which, by a steep ascent of three miles, leads to the ancient monastery, founded in the eleventh century, and rich in poetic associations.

The road for about a mile passed through straggling groups of old chestnut trees, gnarled, and often hollow, and it afterwards entered a dense and shady pine forest (*Abies pectinata,* D. C.)* Here a number of men were preparing spars for shipbuilding, to be floated down the Arno. The trees belong to Government, and are sold standing for about forty lires each (or 33*s.*); the purchaser takes all risk, and bears all the expense. The fine silver fir forests surrounding the old convent, and which are seen below the crest of the Apennines in travelling from Florence to Rome, are an example of successful reproduction of this tree on a large scale, continued for centuries entirely by planting. These forests are now State property, and are attached to the Royal Italian Forest School. The stems are cylindrical, carrying their girth well up, and, being planted centuries ago, these superb and stately firs have a regular and symmetrical magnificence. The flowering plants observed in the wood consisted chiefly of species of *viola, campanula, anemone, crocus,* and *hyacinthus.* The water of the *Vicano,* a mountain torrent, is utilised in various ways. A meal mill is situated under the convent, and an agricultural establishment, of considerable extent, formerly belonged to the monastery. The land was well cultivated, and the monks introduced the potato into Tuscany—it grows well here.

* The silver fir of Europe, *Abete, Abezzo,* Italy.

Classical Allusions.—For centuries the fame of Vallombrosa, as a place of learning, piety, and natural beauty, has been widespread, and its charms have been celebrated by three great poets who have visited it—Ariosto, Milton, and Dante.

> "Thick as autumnal leaves that strew the brooks
> In Vallombrosa, where the Etrurian shades
> High over-arched, embower."
>
> —*Paradise Lost*, i. 303.

And again, in describing the approach to "delicious Paradise," Milton sings—

> "And overhead up grew,
> Insuperable height of loftiest shade,
> Cedar, and pine, and fir, and branching palm,
> A sylvan scene; and, as the ranks ascend
> Shade above shade, a woody theatre
> Of stateliest view." *Ib.*, iv. 137.

Mrs. Browning, speaking of Milton, says :—

> "He sang of paradise and smiled,
> Remembering Vallombrosa.

Here also Dante loved to walk. A more magnificent scene is not to be found in Italy. The immense building, which formerly lodged one hundred Benedictine monks, reconstructed in 1637, and adapted to its present use in 1869, is a stately and commanding edifice, without any pretensions to architectural beauty. Over the door-way is a stone commemorative of the opening of the Forest school, on the 15th August 1869, bearing an inscription, recording that the institution was established in the ninth year of the united kingdom of Italy, when Victor Emmanuel was Sovereign, Minghetti, the Minister of Agriculture, and Ferraris, the Minister of the Interior. The site was remarkably well chosen. It is sheltered on three sides from the cold winds, and though the snow lies deep for three months, it is a delightful climate for the eight months when the students reside there. The sheltered nook is surrounded with great masses of wood. Above the convent is the hermitage, called "Il Paradisino," situated on the point of a precipitous rock, whence the eye can trace the Arno winding through the fertile plains of Tuscany to Forence and the sea. Higher is a point whence I was told both the Mediterranean and Adriatic may be seen.

Origin of the Forest School.—The following sketch of the history and constitution of the Forest school is mainly condensed from the *Bollettino Forestale*, by the director, A. di

Bérenger, 1872. The Royal Forest School of Italy has, within the last ten years, been established at Vallombrosa and Paterno, two estates obtained for the purpose by purchase, situated on the Apennines, about thirty miles from Florence. Paterno, 1,215 feet above the sea, was formerly the castle of the Counts Guidi, and, from November to March (four months), is the head-quarters of the Forest school, which, for the remaining eight months, is located at the higher elevation of Vallombrosa, 5,556 feet above the sea. Vallombrosa existed as a monastery from the eleventh century up till 1865, when the duchy of Tuscany was annexed to the kingdom of Italy; and, among other changes, the sale of ecclesiastical property was determined upon by the State. Among the many strangers who, every summer, visited the monastery of Vallombrosa, was Signor Commendatore Biagio Caranti, president of the council, administering the Cavour Canal, who, struck with the regularity and vastness of the surrounding woods, conceived the idea of providing in them for the technical instruction of the numerous forest employès in the kingdom. No time was lost in carrying this project into execution; and, having obtained the royal sanction in 1867, the present director, Cav. Adolfo di Bérenger (formerly in charge of the forests near Trieste, under the Austrian Government) was appointed to organize and superintend the undertaking. Two professors were at first associated with him; and with this staff, a course of instruction, extending over three months only, was begun in October 1867. It was not, however, till 1869 that all the necessary steps for the transfer of Vallombrosa and Paterno were completed.

Extent.—The extent of woodland attached to the Vallombrosa monastery was classified thus:—

	Ettari (hectares).
Abetina (pine forest) . . .	245,147,040
Faggetta (beechwood) . . .	62,184,377
Marronetta (chestnut) . . .	150,724,695
	458,056,112*

(2 hectares are equal to nearly 5 acres.)

* As this area would be equivalent to about one million and a half of English square miles, we presume there must be some mistakes in the figures given.—The Editor.

As soon as the Minister of Agriculture assumed the direction of the lands, conservancy measures were introduced, the woods during provious years having suffered greatly from neglect. The various provinces of Italy were at the same time invited to contribute towards the expenses of the institution, according to the number of pupils educated, which all did, with two exceptions. The formal opening of the Forest school took place in August 1869, with the names of twenty-five pupils on the roll.

The institution, with its director and two professors (now increased to five), had many difficulties to surmount in the hitherto untried path on which they entered. These were overcome by the help and support given by the Department of Agriculture. At last the course of instruction was regularly established, and the institution began to acquire the scientific materials and appliances necessary for carrying it on. These are gradually increasing, and comprise the following:—The library, containing now over 2,000 volumes of forest literature, including the official publications of the Forest Administrations in France and Germany; a chemical laboratory, well furnished with needful apparatus; a meteorological observatory, where the indications of the barometer, thermometer, pluviometer, anemometer, hygrometer, along with two different instruments for evaporation, and a compass and seisometer, are regularly recorded; a collection of instruments for surveying and tree measuring; arboricultural instruments; models of timber slides made in Germany; timber-carts and objects of natural history; sections of timber, indigenous and exotic; and two arboretums, one at Paterno, showing the vegetation of South Italy and tender exotics, the other at Vallombrosa, with the trees of the Alps and North Italy, and containing nurseries and plantations in which resinous trees are especially cultivated, for planting on the summits and slopes of the Apennines. Besides, indigenous conifers, *Abies pectinata*, *Picea excelsa*, *Larix Europæa*, *Pinus sylvestris*, *P. Austriaca*, *P. pinaster*, *P. halepensis*, *P. brutia*, *P. laricio*, *P. pinea*, *P. cembra*, *Taxus baccata*, and *Cupressus sempervirens*, the following Himalayan plants, raised in quantity from seed sent by Dr Brandis, Inspector-General

of Forests, India, are being cultivated to a considerable extent: *Abies Smithiana*, *A. Webbiana*, *A. Kutrow*, *Pinus excelsa*, *P. longifolia*, *P. Gerardiana*, *Cedrus deodara*, *Cupressus torulosa*, and *Fraxinus floribunda*.

Internal Organisation.—The management of the institution is vested in the director and the professors or masters, who meet in council once a fortnight, or oftener, to deliberate on the progress of the establishment, and to plan the working of the annexed forests. The director is in communication with the Government, and submits all disputed or doubtful matters to the minister of agriculture, industry, and commerce. The professors are appointed by the king, on the recommendation of the minister, and are selected by preference from the list of forest officers. The assistants are nominated by the minister, on the recommendation of the director. The inspector of forests prepares a working-plan of forest economy to be approved by the director, and sanctioned by the minister. The Council of Direction fix the text-books, the dates of excursions, &c., suggest changes in school management, and prepare the annual budget.

Publications.—The *Giornale di Economia Forestale* and the *Bollettino Forestale*, edited by the director, and published in Florence, are the official organs of the Forest School. Syllabuses of lectures and memoirs by the different professors printed in these are used as text-books by the pupils, along with the manuals employed in the Forest academies of Münden and Tharand in Germany, and of Nancy in France.

Admission of Pupils.—The number of pupils admissible to the institution is 60; of these 40 are regular pupils, from all parts of Italy, who aspire to a career in the Government Forest Service, and private pupils, the number of whom is not fixed. Each pupil must present a certificate of being over 18 and under 22 years of age; a second, of good conduct; and a third, of good health and strong constitution. Besides this, every candidate for admission must find security for the payment of 700 lires annually for three years for board, and 200 lires for uniform. The board is paid half-yearly, in May and November. The regular pupils are required to undergo a preliminary examination in the

language and history of Italy, geography, natural history, arithmetic, algebra, geometry, physics, and chemistry.

The pupils assemble at six A.M. in summer, and at seven in winter. Breakfast is served at eleven, and dinner at six P.M., and at nine all are required to be in the institution, and to retire to their own rooms. The hours of instruction are, with some little deviation, from seven to eleven A.M., and from one to six P.M. The inmates of the institution are called together by the sound of a trumpet. When at Vallombrosa the senior pupils have separate apartments, but at Paterno they occupy a common dormitory. There is a suitable room in which invalids are located, and a store of medicines.

Discipline.—The pupils cannot leave the precincts without the written permit of the director. They wear the uniform of the institution, which is that of a forest guard, with oak twigs of gold lace on the collar and cap. Insubordination is punished according to its degree, by admonition of the director, by confinement, or by expulsion, under sanction of the Minister of Agriculture.

The *Course of Instruction* is as follows:—

FIRST YEAR.

Mathematics, including Arithmetic, Algebra, Geometry, and Trigonometry.

Chemistry.—Organic and Inorganic, with experiments.

Natural History.—Botany, Systematic, and Vegetable Physiology.

Forestry.—Theoretic and Practical.

Languages.—Italian, German, and French, with Reading, Writing, and translating of Forest Literature.

SECOND YEAR.

Mathematics applied.—Differential and Integral Calculus, Conic Sections, *Measuring of Heights of Trees and Cubic Contents*, Plan Drawing, Valution Surveys.

Climatology and Forest Meteorology.

Natural History.—Botany, Dendrology, Forest Entomology, Geology, and Mineralogy.

Forest Economy.—History of Forest Science, Practical Sylviculture, Seasoning of Timber, &c.

Elements of Agriculture.—Improvement of Soils, Pasturage, Drainage, Agriculture, &c.

Languages.—Exercises in Italian, German, and French.

THIRD YEAR.

Mathematics applied.—Rates of Growth of Trees, Mensuration, Civil Architecture, Hydraulics.

Forest Administration.—Statistics of different Woods, Classification of Forests, Planting of *Dúnes*, *Maremma*, Marshes.

Forest Law and Jurisprudence.—Communal Rights, Pastoral Rights, &c.

Economy.—Political and National.

Languages.—Exercises in Italian, German, and French.

The first year is mainly devoted to scientific training, and in the second and third year the practical details of forest management are inculcated. For this purpose tracts of land are set apart bearing evergreen and deciduous trees of various ages, to be managed by the elder pupils. Each has also charge of a portion of the nursery, where he digs, waters, and prepares the soil, sows seeds, and performs all the needful operations with his own hand. As the design of the Forest School at Vallombrosa is to train able and skilled administrators, theoretical instruction is throughout combined with practical demonstration.

Excursions.—The pupils make frequent excursions, some with the Professor of Natural History, for the collection and classifying of natural products; some with the Professors of Mathematics and Surveying, when they make plans and elevations of the surrounding lands, calculate the amount of timber, and describe the management, according to the manner prescribed in the rules; those under the personal care of the director, for other exercises in practical forestry. Each year a long excursion is made to some wooded district belonging to the State, or to a private individual. On one occasion (1871) the excursion was to Naples, to visit the International Exhibition of Woods used in Ship-building, and afterwards to remarkable woods in South Italy, occupying altogether four weeks.

Examinations.—Every six months the progress of the pupils is tested, and there is a final examination at the close of the third year, when the professors in council declare the successful pupils to be "approved unanimously," or "approved unanimously, with commendation." Vacancies in the Forest Department are reserved for the passed pupils of the institution.

My time unfortunately did not allow me to remain more than one night at Vallombrosa, but I was much pleased with

the good order prevailing in the establishment, and with the practical training out of doors. The director is a man of great ability, and brings learning and administrative talent to bear upon his work. He has availed himself of the experience of the best forest administrators in France and Germany in framing the regulations and curriculum of the institution under his charge, and strives to impart solid instruction in hydraulics, civil engineering, and the collateral branches, so as to equip the students thoroughly for useful service. Cavalier di Bérenger's published books and pamphlets, upwards of thirty, show how well versed he is in the details of forest management, and all that relates thereto. Among these may be specially mentioned the *Archeologia Forestale*, 806 pp., Venezia, 1859—63, a work of great erudition, giving the history of forest jurisprudence in Italy, which had been brought to my notice by the Hon. G. P. Marsh, U.S. Plenipotentiary at Rome. Another memoir of great value is, "On the Absolute Influence of Forests on the Temperature of the Air," Florence, 1871. Both of these works received special medals at the International Exposition of Naples, 1871.

Director di Bérenger's duties require much tact, vigilance, and perseverance; and I am sure that if the Italian Government give him the support he deserves, the result of his labours, so far achieved, will bring much honour to the nation, and lasting benefit to the country.

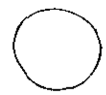
Valuation or Counting of the Forest.

Mr. Baden Powell, Conservator of Forests, Punjab, in his notes on "the demarcation of forest area" in the January (1877) number of the "Indian Forester," mentioned two methods of counting trees, one by Dr. Schlich and the other by Mr. Amery. I should like to add a third plan tried by me several years ago in those fine Sissoo forests of the Katchi.

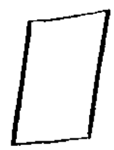
Trees were classed according to girth, thus:

Under 4 feet	—	4th class.
4 to 6 „	—	3rd „
6 to 8 „	—	2nd „
8 to 10 „	—	1st „

Each class of tree was represented by a piece of paper of a certain shape.

1st class — 

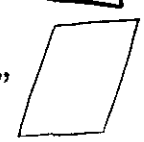
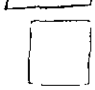
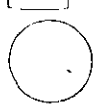
2nd " — 

3rd " — 

4th " — 

A party of 20 coolies were arranged in line about 50 feet apart, each man had slung from his waist a pot of paste and also four bundles of the above classified paper, 100 in each, strung on at the edge to strong thread and arranged in line in the above order. He was also provided with a cord knotted at 4, 6, 8, and 10 feet.

It was easy for the cooly to know which paper to paste on.

1st knot,		or the 1st paper on left hand side.		
2nd "		or the 2nd	do.	do.
3rd "		or the 3rd	do.	do.
4th "		or the 4th	do.	do.

The tree having been measured breast high, according to its class a piece of paper was quickly pulled off from its bundle and stuck on with the thumb and forefinger. An additional stock of paper in bundles of 100 in each was in charge of a Forester who supplied the different shapes as they were used up, and kept an account of them. When all the trees in the

forest were counted the Forester in charge took over the balance of papers in possession of the coolies and, after counting them, deducted the number left of each class from the totals issued, and thus I arrived at a correct estimate of the trees in the forest.

I found this method simple and accurate. The papers are so easily seen on the trees that it would be almost difficult to omit any trees or mark them twice over. It has also the merit of costing very little and in the case of extensive forests, by adapting it to Dr. Schlich's plan of running a line through and counting trees on either side to a certain fixed distance, it would, I feel sure, be found to answer well.

ROBIN HOOD.

*** *For Illustration see other side.*

A Simple Clinometer.

TO THE EDITOR OF THE "INDIAN FORESTER."

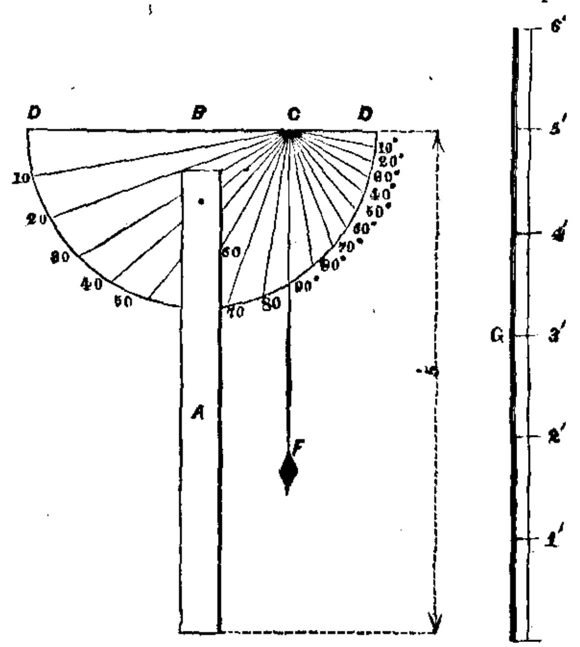
SIR,—I send you a drawing of a very simple "Clinometer" which I made with my own hands, and one which I found very useful in laying out a water-course over a mile long, and also in laying out the lines for a plantation on a steep, and in parts, irregular slope. I hope it may prove of use to some of your readers.

A is a bamboo of about 1″ diameter ; B is made out of any wood that is not liable to warp or crack, and is let into a slit cut out of A and fastened by a nail, but not so fast as to render it immovable. At C a notch is cut, from which hangs a string with a plumb-bob F. D.D are two pieces of tin with eyelet-holes flush with the top of B. which must be perfectly level. G is a staff, bamboo for preference, divided into feet and inches, and about 9 feet long. From the top of B to the ground is 5′

Suppose it is required to lay out a road of which the gradient shall be 1 in 30. Set up the clinometer level, and get a man to keep it steady, so that the plumb cuts 90′. Take the staff G off 30 feet, and then have have it moved up the hill until DD


4th Knot
3rd do
2nd do
1st do

and the 4′ mark of the staff are level. From the foot of the "clinometer" to the foot of the staff is the slope required. By



simply tapping B up or down, and marking what angle the plumb cuts, the slope of any hill is easily found out.

Yours truly,

C. E FENDALL,

Sutlej Division.

Vitality of Teak.

Under this heading Muhafiz-i-jangal, in the last number of the *Forester,* asks for information from, amongst others, the Bombay Presidency. I can give him an instance even more striking than those quoted by him. When demarcating in April 1872 a boundary mark had to be placed on the bank of a nálá. The boundary marks were usually formed by building a cairn of stones round the butt of a teak rafter placed upright on the ground. In this instance, however, my attention having been called to the fact, that this cairn, if so built, would probably be washed away,

I had the butt of the rafter, a perfectly freshly cut one, buried 18 inches in the soil. The following year, being near the spot, I went, out of curiosity, to see how this cairn had stood, and found, to my astonishment, that it had taken root. I saw this rafter only a few days since, and it would be difficult now to distinguish it from the surrounding trees, were it not for the cairn at its foot. I should say, however, that this is the only case I have ever seen, and all my attempts to get cuttings of teak to strike have signally failed.

GHATI.

April 6th, 1877.

Loss caused by Jungle Fires.

TO THE EDITOR "INDIAN FORESTER."

DEAR SIR,—It may interest your readers to see the results of an estimation which I have made as to the pecuniary loss by damage done by jungle fires in this district.

In the Sidli Forests, which are divided into compartments, each a square mile, the extent of every fire, during the past year, has been marked approximately in the map; and thus a very fair estimate made of the area burnt, which was put down at 6,930 acres, out of a total area of 27,146, in which fire conservation was attempted. From valuation surveys made in 835·22 acres we get 24,000 sal trees from 1½′ to 3′ in girth, averaging 40 years in age; 3,300 from 3′ to 4½′ in girth, averaging 70 years in age; 127 from 4½′ to 6′ in girth, averaging 100 years in age, and allowing 2 trees under 1½′ girth for every one of the first category counted, as trees of less than 1½′ were not counted in the valuation surveys, we get 48,000 trees under 1½′ averaging 14 years in age. Now taking a year's growth as our unit, and for simplicity supposing this uniform throughout the life of a sal tree up to 100 years, we get 672,000 as the number of units in the trees under 1½′ in girth, 960,000 for the second category, 231,000 for the third, 12,700 for the 4th, giving 18,75,700 units of annual growth as the total produce of 835·22 acres; this gives 2,245 as the annual produce in units of growth per acre.

Now we can assume that the growth of the forest is at least doubled by fires being kept out, as some portions are dying out and at the best a very meagre growth is maintained when jungle fires are annual occurrences. The loss per annum from fires is therefore estimated at 1,120 units per acre.

The price of a sal tree 100 years old is Rs. 8 in Assam;* and thus the value of the damage done is Rs. 90 per acre omitting decimals, or for the 6,930 acres burned in the Sidli Forest Rs. 6,23,700. The cost of fire conservation proved to be, for the area preserved 20,216 acres, Rs. 16 per square mile, or the value of two mature sal trees.

I am aware that the calculations which I have made involve several *assumptions*, but it is more to the method which may be improved than to the results to which I invite criticism.

W. R. F.

Erosion by Rivers.

TO THE EDITOR, "INDIAN FORESTER."

SIR,—Can any of your numerous correspondents give any practical suggestions respecting an effectual, and at the same time inexpensive, method of preventing erosion on river and island banks.

In the division of which I hold charge, upwards of 450 acres of the finest alluvial land belonging to this department have been carried away by the action of the *Jhelam* and *Chinab* rivers during the last two years, and in some cases thriving plantations of *Shisham* have been entirely swept away.

I may also mention that the land carried away belonging to this department is a mere trifle in comparison with the damage done to *Shamlat* land along the banks, some villages being left almost entirely without arable land for several years, till the main course of the rivers again change, if the villages themselves are fortunate enough not to be washed away in the meantime.

* We are pretty certain that the value is much more than Rs. 8 per tree.—THE EDITOR.

The method of sloping the banks and then planting them with willow cuttings has been tried, but has not apparently been attended with much success, as the willows had not sufficient time to take a firm hold of the soil when they were swept away by the annual floods.

A system of "fascines" supplemented by willow planting, if it can be executed at a reasonable cost, seems to be the proper method to pursue, and any information with respect to the dimensions, cost, and mode of fixing the "fascines" will oblige.

Another method suggests itself which might be attended with success, *viz.*, to plant several thick lines of willows at a *certain distance from the edge where erosion is threatened*, so that the willows will have two or three years to take a firm hold of the soil before the water arrives at the line, the outside strip of land being of course sacrificed for the protection of the remainder.

It is perhaps, however, unnecessary to observe that the success of this proposal rests on the capability of willow roots to prevent erosion without supplementary aid, and any one experienced in willow planting will oblige by stating his views on the subject.

Yours faithfully,

E. Mc. A. M.

Bagneris' "Manuel de Sylviculture."

TO THE EDITOR OF THE "INDIAN FORESTER."

DEAR SIR,—I am happy to be able to inform you that a new edition of the translation of the "Manuel de Sylviculture" (Bagneris) will shortly be published in London, and a certain number of copies will be available in this country. Further particulars will be announced in your October number.

I remain,

Yours truly,

A. SMYTHIES.

30th June, 1877.

THE

INDIAN FORESTER.

Vol. III.] OCTOBER, 1877. [No. 2.

The Natural Reproduction Treatment of Deodar Forests.

It is my design in this brief paper, to put together some observations which have occurred *to me or been noted down*, during many visits to the Deodar forests in the valleys of the Beás, Sutlej, Chenab, Ravi, and Kaghán rivers.

They are not theories but observations of practical results, and conclusions drawn by inference (I hope legitimately) from such observations. But all such conclusions, with regard to a species which has never been studied, and no attempt to treat which (*under conditions of high forest for natural regeneration*) has ever been *systematically* made, will necessarily be open to question, and to large addition and amendment.

Still I feel that the time has come to commence the little snowball. I trust others *will help to roll it along*, so that it may gather material as it goes, and that ultimately we may be able to build *it up*, and to shape it into something worth looking at. I trust the charitable reader will exonerate me from any desire to dogmatize on a subject so little known; and I have consequently to make a general apology when I say "such a thing does not happen with regard to Deodar, or such a thing *is* so:"—*I mean to say that it is, or is not so, as far as my own uniform* observation goes. I do not wish to contradict any one else's observation and knowledge, and shall only be *too glad to be set* right, and to receive, through the medium of this journal, as many corrections as possible. *Only it seems to me* shorter to make this qualification once for all, than perpetually to repeat the phrase, "as far as I know"—"this at least is the uniform result of my observation" and so forth, over and over again.

Dealing as the question at issue does, with the chief timber of the Punjab, it is one of vital importance. It is true that we have other excellent woods,—some that have not yet been fully tried. But the successful utilization of a considerable portion of our thus available material depends on impregnation; and until we are able to produce locally some efficient substitute for creosote,—the element, which pure or combined, is almost the only reliable preserver,* impregnation will always be so costly as to make people hesitate to employ it. Hence, while allowing due weight to the impregnation question, and still urging that it would pay well to introduce its use at once on the State railways, the Deodar question *will always* remain of great importance for the Punjab. Though the North-Western Provinces have a supply of sâl nearer the plains than their Deodar resources, still the question of deodar growth is, even there, by no means without its importance. Large sleeper operations have already been conducted to a highly successful issue, and may be again at any time required.

In order to complete even the skeleton of the subject, the demarcation of deodar forests ought to be dealt with; but on this I shall only make one remark, *viz.*, that it is often, if not chiefly, with ruined forests, whose original area has been curtailed, or whose surviving contents have been injured (often both) that we have to deal. In demarcating we must not confine ourselves to taking the now remaining patches of Deodar. This is the mistake, though a natural one, that has been made in our earlier demarcations in the forests of the Ravi, Chenab, and Beás. All have now to be rectified in consequence. We must take the surviving patches only as *nuclei* with either scrub jungle or inferior tree-forest all round, so as to get hold of manageable blocks of land, which at present may only contain a few groves of deodar, but which will in time become good and compact deodar forests. The moment an existing deodar forest is thus got hold of and the area adjacent protected (assuming a fair allowance of good seed years) the forest *will*

* I do not mention the mercurial bi-chloride process, for that, besides being very ill adapted to pine woods, is even more costly than creosote.

spread naturally. Of this there is no sort of doubt. The best natural reproduction is on the edges of existing blocks of forest, wherever there is not some very unfavourable condition, as of matted turf, or some superficial soil obstruction, which the radicle of the seed cannot penetrate. In such cases partial clearing, turning up turf in strips, &c. may be needed. In eight cases out of ten, however, it is only necessary to fence the waste land adjoining and leave it. This is especially the case where there are groups of mature trees or single ones scattered about in places *above* the enclosed but still barren lands.

I do not in these remarks allude to cases where a patch of Deodar forest is adjoined immediately, not by scrub or waste lands, but by tree-growth of other species, or dense copse of inferior trees. Here, no doubt, clearing in the vicinity of the Deodar is needed. To this I will return presently.

In working Deodar forests, we are in some cases compelled to cut by selection. When the forest is very high up and on steep rocky slopes, the selection system is the only method that presents itself. Then the general object is never to uncover at any one time anything like a considerable area of soil—otherwise we may cause the denudation of the rock of what little soil covering it possesses, and possibly give the first start to ravines, incipient torrents, and their consequences.

But in cases where the slope is more gentle, and the altitude not extreme, then we are able to treat the forest for natural reproduction, supposing other conditions to be favourable. Unfortunately it too often happens that our existing forest is in a condition exhibiting a confused mass of trees of all ages, irregularly grouped, often interspersed with *Pinus excelsa* and other species. Old, dead, and dying trees are dotted about, and numerous blanks, occupied by shrubs, like *Elsholtzia* and *Indigofera*, and by rank herbaceous vegetation, are found. This is usually the result of fire, or of that method of cultivation (now fallen into disuse in these localities) which still survives in other parts under the names of "*jhum*", "*toungyá*" "kumri," &c. In such cases the only treatment to which the forest can be subjected is not one either of selection,

or natural regeneration, but of conversion or restoration. The old and dead trees have to be got rid of, but good seed-bearers steadily reserved,* the blanks have to be artificially cultivated: or in some cases on observing an approaching seed fall, it is good (when herbage is not high) to clear patches of land and *lightly* work the surface all round the seed-bearing centres. This to be done the last thing in autumn before the seed falls.

But supposing that we are dealing with a forest still possessing a considerable extent of forest of mature age fit to be cut under "the natural system."

Taking this first, I should observe that ordinarily the words "natural regeneration system" call to mind a series of cuttings technically termed the primary or preparatory, the secondary and the final. The primary cutting or cuttings (for they may be gradually executed) have for their object the preparation of the soil, and the admission of sufficient light and heat to ensure the germination of the seed that falls. In that view, the cutting may be either close or open according to the nature of the young plants. And in our text-books general rules are given (of undoubted value) as to when the primary cutting should rather tend to closeness, and when to openness.

My first point submitted with reference to deodar is that it does not answer to distribute the primary cutting rather uniformly over the given area of operation, so as to produce a mere chequer of sun-light over the ground. Under such conditions nothing but a very occasional seedling will come up.

If you notice a good seed tree at the edge of the forest or of an open glade, you will observe that quite in the open as regards light, close round the tree, but not close *under* it, a dense carpet of young seedlings has come up. Lateral shelter they require, and this they get from the trees after a certain hour of the day, according to the situation, after the sun has reached a certain angle. Young Deodar, exposed to the full

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* I cannot help noting the fact that in old days the contractors used to fell trees high above the ground often 6 to 10 feet, but if the least bit of a branch was left on the stem, the stool would not die, but sent up several shoots. These, though worthless for timber, may be very valuable in the forest, as they yield seed as well as the best-shaped trees, being quite healthy. Several such may be seen in Kalatôp Forest near Dalhousie.

blaze of a vertical sun for any length of time, will not survive especially in a dry soil.

The seed of the Deodar, I may here remark, is comparatively heavy. It is carried but a short distance laterally from the trees.* The only case where it travels far, is on a descent or on lower slopes. Those who have, from the vicinity of Bâtri (Chamba State near Dalhousie) looked up at the series of slopes piled one above another, and culminating in the Kalatôp ridges (from 5,000 to 7,000 feet), will remember the groups of secondary growth of deodar far below the Kalatôp forest, but evidently derived from it.

Returning, however, to the growth of Deodar seedlings, they will not come up under cover; when firmly established, indeed, the young plant will endure a considerable amount of shade remarkably well. This may be seen at Simla, where, in increasing numbers, tall delicate points of deodar may be seen overtopping the oaks (*Q. incana.*) *But here it is evident that the* natural seedlings (which are always sparse, and never in masses, as we would wish to see in a good naturally regenerating forest) have established themselves at points where they found the requisite light to commence life with. Afterwards, the oak boughs grew and the Deodar plants being sufficiently established, were enabled to feel for the light, (if I may use the phrase,) and push up their graceful leading spray through the oak foliage. But Deodar will never spring up in a mass under cover

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* *Vide* working plan for sutlej Forests, 1875.

"Trees inside a compact forest may be full of male flowers, but will often not yield *seed. The chief seed trees are isolated or trees* above cliffs, or in lower forests those which have well-developed and open crowns."

"The seed ripens in November: scales and seed fall together; often the whole cone at once leaving the bare central axis. The cone falls apparently through the drying influence of the sun. I have heard it fall on quiet days in the middle of the day, and nearly ripe cones fall into bits in the sun without being touched. For this reason the seed is easily collected even after its fall. The seed is about ⅝ inch in length, and ¼ of an inch broad, is heavy; 210 to 230 to the ounce, and generally falls *close to the mother tree.*"

The seed itself, if healthy, has a completely developed embryo of a light green color, surrounded by a soft albumen and lying in a soft shell full of resin. This tends to make the wintering of deodar seed a matter of some difficulty * * * * * The young tree though kept back for a long time by surrounding trees will rapidly recover as soon as these are removed, but the condition it loves best is a side shade, especially against the South and East.

The *tree avoids ill-drained soil, though it likes moisture in the air and heavy rain*-fall. The young tree is killed by fire but recovers quickly from other injuries."

Note by B. Ribbentrop, appended (p. 28) to Sutlej working plan for 5 years from 1875-1879.

as the *Abies Webbiana* will under *Quercus semecarpifolia*, or the latter under the former (both may be seen on Hattu near Simla.)*

Two very interesting cases regarding sowings of Deodar may here be cited from the Beás forests.

On the Upper Beás, at a place called Dudlú, there is a patch of cut-out forest which was completely cleared of trees; the grass and weeds were removed, and Deodar sowings made. The seed came up well; when it was visited in 1876, it was found that a dense growth, over six feet high, of wild balsam and other herbaceous vegetation, had covered the ground; nevertheless the seedlings were all alive and well.

On the Parbatti (the main tributary of Beás) at a place called Somâ-Chaláon, sowing (broad cast) of deodar had been made at the bottom of the valley, *i.e.* at the bottom of the slope which is, in fact, a "*talus*," coming down from the high cliffs which here hem in the valley. The soil was much drier than at Dudlú, and the herbage consisting of *Gnaphalium*, and other species less succulent and translucent than those of Dudlú, but nowhere much over two feet high, had in places completely killed the seedlings.

Dudlú, however, besides a rich moist soil, is 7,000 feet high (*i.e.* well up the side of the open valley), has a south-west exposure, and so gets the sun nearly all day. Hence a sufficiency of light would penetrate, and very possibly the more watery membranous character of the herbage had something to do with it, as well as the moist, rich soil which made the plants more vigorous. Somâ-Chalâon is at the bottom of a rather narrow valley, with a north exposure; the poor soil and possibly the harder, more wiry character of the herbage, affected the Deodar.

It is also true that Deodar usually prefers northern exposures or the shady side of valleys, until it comes very far north-west and in higher latitudes; for instance, in Kàghân (the most

* At the very place where I am writing, just below me, is a small forest of pure *A. Smithiána*, my own property. In the upper portion, and quite under a cover (which is not very dense), a complete young growth (natural) of *A. Webbiana* is coming up. In course of time, the character of the forest will completely change. There are no mature *Webbiana above* the forest, but a few at some little distance to the west in a ravine.

north-westerly of our Deodar valleys), the main forests are on the sunny side.

I have been much struck in reading an account of *Abies excelsa*, in a recent number of the "Revue des Eaux et Forêts,"* with the similarity of the treatment recommended to that I would apply to Deodar.

The Deodar seedling is not indeed quite so delicate. I do not know of any instance in which the radicle is unable to penetrate an ordinary layer of decaying leaves, to the extent noted in the case of the Alpine spruce; but certainly short-matted turf is against it, and wherever this is found, it is necessary to remove the obstruction by turning up the sods leaving them grass downwards. This may be done in strips or patches according to the ground.

Deodar cannot abide heavy ill-drained soils. Old rice fields are most difficult to cover. Thorough trench-draining and the repeated ploughing or hoeing up of the surface with subsequent pulverization of the clods, will be necessary to make the sowing, or treatment with transplants, of such ground, possible.

Here also I would remark, that as good seed years of Deodar do not occur successively, and are said with some probability to happen only once in three years, this circumstance should be borne in mind in all operations. It is rare indeed not to see a multitude of upright male flowers, which, at first sight, especially to the non-botanical eye, appear like incipient cones. But they soon open, and in October shower their yellow pollen about in profusion. In Kulu, I have found this collected by the natives and used as paint in decorating walls of temples and houses. The cone takes from 24 to 26 months to ripen, so that good long notice is to be had. While waiting for a seed-year, grazing of cattle may be allowed, and a growth of weeds (if not so powerful as to necessitate *expensive* clearing) need not be looked on with despair. But when everything is ready for the seed shedding, ground must be prepared, weeds removed, turf turned up, and cattle at once excluded.

Another point I should like to be informed about is how far the fact that the Deodar is in some specimens dioicous in other

* June 1877.—L'epicéa dans les Alpes.

monoicous, affects the selection of trees for cutting. In case of such trees in groups one might cut away all the cone-bearing trees, leaving only the males. It is true, however, that the pollen is easily carried by the wind to a distance.

To return now to the direct question of the primary cutting, I urge that it should not be made by single trees selected evenly over the area of exploitation, but should be made in groups or bouquets, the object being to make a number of wells or holes, from place to place, in the forest.

In two mature forests on the Beás, called Latúra and Bláj-dhár, I had carefully hoped to secure a good show of seedlings by distributing the cutting and making it rather open. It was *made more open than I ought to have allowed, because there* was considerable danger for the trees left standing from storms of wind; nevertheless, the amount of light wholly failed to produce anything more than a very few seedlings here and there, although a rich growth of herbs was produced. It may be replied that the cutting was too open, and that it encouraged a rapid growth of weeds before the seed-fall. That could hardly be the case however, because in a few places where there was but a slight growth of weeds, there were no more seedlings than in the denser portions. Moreover, all experience tells us that a mass of weeds may come up under shade that would not admit of the growth of Deodar seedlings, even if the weeds were kept down by artificial clearing.

It has become necessary on the Beás to cut a certain number of trees within a limited range, in order to fulfil a contract; so rather than begin cutting in new and uncounted forest, I have thought it better to cut out a little more from these already worked forests. If the cutting has been such as to leave several open spaces not too broad (say 80 to 100 feet), it will, I have no doubt, be found that the next good seed-year that occurs, if the weeds that have grown up under the former *régime* are cleared (as they must be; this is the penalty of our mistake), there will come up a perfect carpet of seedlings.

The *first cutting then,* is *not* to be done by taking out a series of individual trees, tolerably evenly distributed over the areas under cutting, but in groups from place to place, leaving

completely open patches with *nothing over-head, but with lateral shade* from neighbouring branches, and that shade which falls over the whole, from the trees surrounding, when the sun has passed a certain angle.

When these glades are stocked, then the intervening masses of old trees will be removed, but always, so that (except in places quite secure against wind) single trees are not left standing by themselves, but in groups of three or four.

No secondary cutting is then made; or rather the whole is done in two cuttings; first, the cutting out of groups, and then the cutting out of what remains between the groups, leaving only such small clusters of standing trees as may *serve to stock the last opened-out glades*. This has to be attended to, for supposing that, having re-stocked two glades, leaving a group of old trees between, we were then incontinently to cut away the whole of the old group at once, nothing would occupy its place, as the young growth on either side would not be seed-bearing.

The precise form of the wells or glades to be opened out has yet to be determined. My idea is that they should be elongate so as to approach the form of cutting by "short belts at intervals." In some cases the formation of the ground may actually suggest the cutting in the form of small strips from point to point.

Wherever aided reproduction is necessary, if planting is indicated, the form of planting in lines,—the trees close in the lines, and the lines from 15 to 25 feet apart, according to circumstances, should be adopted. If sowing, then sow in small patches, sized according to the ground, the patches having the surface lightly (and never deeply) worked, and being always ranged *in lines*, at some distance apart.

Broad cast sowing is rarely if ever desirable. The advantage of the line system is that the trees having abundant lateral space, the branches will in time touch, and so suppress the intervening vegetation. On the other hand the trees being put in close together *in* the lines, say, 1 foot to 18 inches apart (but further if the soil is good, and success is highly probable), leads to this that even if a considerable percentage die, still enough will be left to stock the lines.

Where the land to be planted is covered with bushes, following the principle of lateral protection,—lines or bands should be *completely* cleared of vegetation at the required distance apart, which is regulated by the slope and the *goodness of the soil, which renders an earlier or later meeting* of the branches from one line to another, probable. According to the height and density of the growth, the breadth of these bands should be fixed ; it may be 4 feet or 3, or even 8 to 10 in a higher growth.

The great difficulty has hitherto been to get that continuous supervision which alone ensures the young plants being taken out of the nursery without injury to roots, and being planted in, at the right depth (not buried down to the branches), and the earth well trodden down afterwards. A plan for sowing in short pieces of bamboo has recently been noticed in the "Revue" (as practised in Australia), of this I have given a separate note in this number. The plan will probably answer for Deodar, and as each little case charged with its protected and uninjured plant is put out in the lines, the chances of complete success may be increased.

Those who have visited the Cheog forest near the Fâgû dâk bungalow (near Simla) will have noticed how excellent the natural reproduction is, notwithstanding that the whole forest has been cut down without any rule or any idea that such results would follow.

Of course, a vast number of young trees in the condition of high poles (and not a few low poles) have been taken out, which will utterly ruin the productiveness of the forest at that stage, which ought to have been supplied by the said poles come to maturity, while the present crop of seedlings are still attaining that age ; but still as regards the mere carpet of seedlings, the result is wonderful. Two causes have indeed fortuitously helped this, one being the temple groves standing in the midst (indeed there are 2 or 3 temple forests). Fires have rarely if ever been lighted, at any rate not since the forest has become valuable for cutting for the Simla market, *nor is the place grazed over.* Another cause is that "permits" for cutting were given out and very strictly watched, as a large price (often 12 to 20 rupees)

was paid over each stem. Consequently, the cutting was done in *groups*, rather too large perhaps, but still each man cut his circle so as to have his sawyers, &c. at work close together. The seed reserves were represented by the temple groves alluded to, and by some few trees left in places where they could not be got at to cut. Considering then the very excellent soil, exposure, and slope, the altitude being extremely favourable, and the rainfall abundant, it is easily understood how nature overcame the disadvantages of a cutting which was too severe, and left seed bearing trees only at rather distant intervals, and which would have failed under less favourable conditions.

In fact, the cutting of Cheog may be described as a cutting *in the right way, only exaggerated to such an extent that*, had it not been for an exceptional activity of nature, the result would not have been favourable.

As far as I can learn, something similar has happened in the Lambatâch Deodar forests of the North-Western Provinces. There the cuttings were too severe, but trees were left on the heights above which effected the natural regeneration.

Lastly in the case of those Deodar forests which can only be treated on the selection system,* *I recommend that a similar principle* be aimed at, though of course modified. Here we dare not remove groups of trees to uncover a considerable space; but still wherever it is possible, *i.e.*, wherever it is not necessary to select dead and dying trees only, or wherever the existing growth is not too sparse to admit of more than single stems falling, I would cut out little groups of 3 or 4, up to 7 or 8 trees together, but not more; the higher number only in very favourable conditions.

It should be borne in mind that grazing *must* always be kept out of a "selection" forest *that is being worked*, because reproduction is going on at all points, whereas in a forest worked for natural regeneration, there are always whole compartments not being worked, which, if over a certain age, can be safely opened to grazing.

B. H. BADEN-POWELL, F.R.S.E.

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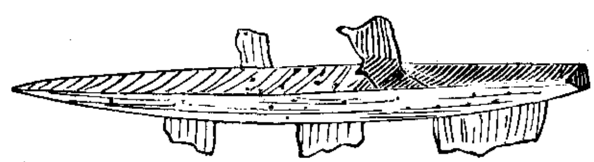
* Those who wish to study these conditions may refer to Bagneris' Sylviculture Translation, page 69.

Parasites of Coniferæ.

SIR,—In June and July many of the Conifers in the Punjab Hills were seen to be attacked by a species of fungus which, growing on their leaves, turned them of a bright yellow colour, and gave out clouds of yellow dust. This dust was collected at Dalhousie by Mr. Baden-Powell and examined. He found it was not of the nature of a dye or pigment, and that it was not altered by ammonia or caustic potash, though the colour was destroyed by hot diluted acid. This dust was formed of the spores of a fungus on the leaves of *Abies Smithiana*, which is identified by Dr. Cooke as *Peridermium acicolum*, Rab.

At the same time I found a similar fungus on the leaves of *Pinus excelsa* and *longifolia* about Simla, which is identified as *Peridermium orientale*, C. It did not seem to attack the Deodar, but in many places the leaves of the trees of *Abies Smithiana*, *Pinus excelsa* and *longifolia* had been turned to a bright yellow, though they did not seem to suffer in their growth from it. I give Mr. Baden-Powell's sketch of the fungus,



P. acicolum, on a needle of *Abies Smithiana*, and enclose a monograph on the genus *Peridermium* which Dr. Cooke has requested me to transmit to you.

J. S. G.

Some Parasites of Coniferæ.

By M. C. Cooke, M.A.—A.L.S.

Following up the communications which I have already addressed to the *Indian Forester* on the subject of the fungoid diseases of Forest Trees, it is my design, on the present occasion, to confine myself to one genus of fungi which appears to be singularly restricted to the *Coniferæ*; and, although somewhat resembling a page or two cut from a Botanical Manual, it appeared to me most advisable to call attention to the subject in

a systematic manner, if I would render any good service, notwithstanding that it might prove dry reading.

The genus *Peridermium* consists of endophytes which burst through the bark of young twigs, or the cuticle of the leaves in the form of sacs or blisters, usually of a small size and pale colour, consisting of a delicate colourless membrane, enclosing, when mature, a multitude of orange spores, which, on the bursting of the sac, are scattered like the pollen of firs, but more brightly coloured. These spores arise from the base of the envelope, or peridium, and are produced, as many as ten together, in a chain; and these chains of spores are closely packed side by side in the sacs until fully matured, when the sac is ruptured and the spores separate and escape. In all the species known the epispore, or outer coat of the spore, is rough. It is not difficult to cause these spores to germinate and produce filaments, but beyond this nothing more has been accomplished.

Peridermium corticolum, Rabh, is confined to the young branches of conifers, and formed a portion of the *Peridermium pini* of Wallroth and Fries. It being evident that two good species have been designated by one name, it is deemed advisable to accept names which are confined respectively to these two forms; and hence *Peridermium corticolum* and *Peridermium acicolum* are employed to designate the two species formerly united under *Peridermium pini*, W. The present species has several points by which it may be distinguished from *P. acicolum*, besides the unimportant one in itself of a mere difference of habitat. The peridia are very large and inflated, often a quarter of an inch or more in length and height, not much compressed laterally; and although without colour in themselves, they appear coloured from the orange spores which they contain. These spores are nearly globose, with a rough, somewhat spinulose, epispore, and from ·02 to ·024 millemetre in diameter. When fully matured the sac-like peridia are ruptured, and the spores scattered as an orange coloured powder. With but one exception, hereafter to be alluded to, the spores are universally of a golden or orange hue. This species is found in France, Germany, and Britain on

Pinus sylvestris. Under the name of *Peridermium cerebrum,* Peck, a form of this species, in which the peridia are more than usually gregarious, occurs on *Pinus rigida* in the United States, but there is no ground for supposing that it has any claim to be regarded as a distinct species, the spores being manifestly the same. How far the prevailing size of the spores may be a safe guide in the determination of species has not yet been quite satisfactorily determined. It is assumed that the size does not differ in the spores produced first at the apex of the chains and those developed ultimately towards the base. Probably the process of development goes on after the peridium is ruptured, and, if so, the later spores, when released from lateral pressure to a certain extent, may have a power of expansion. Of this, however, we have no certain knowledge; but if it should be proved that all the spores in succession, produced by the same fungus, are equal in size and alike in form, then one of the features relied upon in the determination of species is a safe one, and no exception can be taken to the species herein described as *Peridermium corticolum, Peridermium acicolum,* and *Peridermium orientalis,* the crucial point being undoubtedly the unmistakable difference in the form and size of the spores. The presumption based on the examination of European specimens is that the test is a safe one; if such be the case, any confirmation will be acceptable.

Peridermium acicolum, Rabh, as its name indicates, is found on the leaves or needles of *Pinus sylvestris* and other conifers in Europe. The peridia are more delicate and compressed than in the preceding, and much smaller, breaking through longitudinal fissures in the leaves, and when the spores are discharged, are of a snowy whiteness. The spores in this instance are usually much elongated, never truly globose, and from ·035 to ·042 m. m. in length and ·02 to ·022 m. m. in breadth. On account of the form of the spores Fuckel applied the name of *Peridermium oblongisporum* to this species, but the name of Rabenhorst has priority, it was considered as a folicolous form of *Peridermium pini,* before the features which distinguish the form on the branches and that on the leaves was clearly recognized. By comparison of the remarks here made of the charac-

teristics of the two species, it will be observed that the present has much smaller, more delicate, and compressed peridia; the spores are of a brighter and more intense colour, elongated, and on the average twice as large as in *Peridermium corticolum*. The epispore is also rather warted than spinulose. If the two were only forms of the same species, modified by the circumstances of their growth, it would be expected that the large peridia would contain the large spores, whilst the opposite is the fact, and the general recognition of two distinct species seems to be entirely justified. Tulasne found this species in the south of France growing on *Pinus maritima*, whilst it is even more common on *Pinus sylvestris* in Britain, and both species in Belgium. From India I have received it on *Abies Smithiana* from Mr. Baden-Powell, who found it abundantly at Dalhousie in June 1877. The trees were growing at 7,000 to 7,500 feet. His description of the fungus is very apt. He says "it is a growth like a series of small flat sacs, or flattened teeth growing out of the needles, and of a salmon colour; the outer edge is waved and irregular, and the size as to breadth variable. The needles are also covered with brown spots. The fungus grows till the leaf turns quite yellow, and you can distinguish the trees at some distance by these yellow tassels. In this state the envelope bursts, distributing an orange-coloured powder, and leaving ragged fragments of the pellicle attached to the dead or dying needles; the color in the powder (spores) is destroyed by hot diluted acid, but the particles do not dissolve or impart a colour to the liquid. It is not altered by ammonia, and caustic potash has no effect upon it." Notwithstanding this, the colour is so fugitive that before the specimens reached England it was all gone, and the spores were creamy white.

The same species on *Abies Smithiana*, received from Mr. J. S. Gamble, was collected at Mashobra, Simla, in June 1877, at an elevation of 7,000 feet (No. 4468.)

Peridermium orientalis, Cooke.—This has the appearance of being a distinct species from *Peridermium acicolum*, although externally so much resembling it that it seems impossible to distinguish them from each other by the naked eye, except it may be that the peridia or envelopes are more distinctly

striate lengthwise. They are alike in size and form and in being flattened, but the spores, when examined under the microscope, are smaller, more globose, and the miniature spines of the epispore are finer and more numerous. The dimensions of the spores are ·02 to ·022 m. m. in diameter, which is a very appreciable difference from the spores of *Peridermium acicolum*. The cells of the peridium are in more decided parallel rows, so that even the cell structure of the peridia may be recognized under the microscope as differing in the two species. For these reasons I cannot regard it as a mere variety of *Peridermium acicolum*, but this may hereafter be more satisfactorily determined by the examination of other specimens from other localities. *The specimens examined were on Pinus longifolia* (No. 4466) collected at Annandale, Simla, growing at 6,000 feet, by Mr. J. S. Gamble, and also on *Pinus excelsa* (No. 4467) collected at Mashobra, Simla, at an elevation of 7,000 feet. From North America I have evidently the same species on needles of *Pinus australis*, received from the late Dr. Curtis, but the precise locality is not stated. Hitherto it has not been recognized in Europe.

Peridermium columnare, A & S., has somewhat the habit of *P. acicolum*, but the peridia are narrower, more cylindrical, and very much elongated. The needles are not dwarfed or distorted by either of these species as in some others, although they are soon discoloured. The spores are subglobose, measuring from ·02 to ·022 by ·016 to ·02 m. m. The cells of the peridium under the microscope will be found to be elongated and narrow, and in this respect to offer a marked contrast to those of *P. acicolum* and *P. orientalis*, the only two species with which it might be confounded. Usually the needles are discoloured in the neighbourhood of the peridia, elsewhere retaining their green tint. It is probably the least common of any of the European Species, and I am not aware that it has been met with out of Europe. It occurs on *Picea pectinata* and *Abies excelsa*, and probably on some other species of *Picea*; but of this I have no decided evidence, the only specimens I possess being on the two species named above.

It has been remarked that the peridia are accompanied by

little blackish spots. These are related to the fungus, and contain a host of very minute elleptical bodies not more than ·0025 m. m. in length, which are regarded as spermatia. What may be the uses and functions of these spermogonia, and the spermatia which they contain is an open question, their fecundative nature being only assumed by the name *Peridermium elatinum*, (Kunze,) dwarfs and distorts the leaves of the conifers on which it grows. It is very common in Northern Europe, though not so common as *P. acicolum* in Britain. In North America it is said to be common on leaves of *Abies balsamea*, and at the same time it is stated that unlike other species, it attacks all the leaves on the same branch. These have a sickly yellowish hue, stand out on all sides of the branch, and do not attain more than half their usual size. They fall off each year, so that the leaves are found only on the terminal shoots of the affected branches, the internodes of the previous years being entirely destitute of foliage. The fungus, therefore, appears to be perennial, for having once attacked a branch it reappears year after year on the successive crops of leaves, apparently loosening its hold only upon the death of the branch. Fortunately it spreads only outwardly or in the direction of growth. Hence, all the affected branches of a tree, if traced back, will be found to have a common origin, and at this common starting point there is usually a swollen, or seemingly injured, place in the main branch. From this point the ramification becomes excessive and crowded, exactly similar to that often seen in spruce trees when attacked by *Arceuthobium pusillum.* All the branches given off below this point are unaffected ; all given off above are affected.*

In some parts of Germany, and in the district of the Vosges, the silver firs are attacked by this species very commonly, and on account of the manner in which the branches are distorted, the malformations are termed "Hexenbesen" and "Paneurs de sotré" or "Witches Brooms."

There is a great difference in the appearance of the fungus in this species, as well as the next, and the species previously described. The sacs or peridia are but little elevated above the

* Twenty-eighth Report of New York State Museum.

surface of the needles, and resemble blisters rather than sacs, at length splitting and discharging their orange spores. These are rather irregular in form, elongated, measuring about ·024 to ·03 m. m. in length, and ·012 to ·014 m. m. in width, the surface being rough as in other species. The next species appears to be the oriental representative of this, but it may nevertheless be afterwards discovered that the *P. elatinum* itself occurs in places distant from Europe. It is remarkable how little we know of the fungi of Asia; in fact the whole of that immense region is as unknown and unexplored as the centre of Africa, so that the Himalayan region may still yield us all the individuals of this genus which are represented in Europe, as well as those peculiar to itself.

Peridermium Thomsoni, Berk., appears to be confined to India. It was first discovered by Drs. Hooker and Thomson in Sikkim on the needles of *Abies Smithiana*, and first described in the *Gardener's Chronicle* for 1852. The leaves of the fir, when attacked, are reduced in length nearly one-half, curved, and the whole upper surface is occupied by one or more large, more or less elongated pustules, sometimes disposed in two rows. This gives to the diseased tree a strange appearance and at length proves fatal from the immense diversion of nutriment requisite to support a parasite so large and multitudinous. Such is the description first given of this species, and no record is to be found of it except the specimens then collected. The spores are the largest of any known species in the genus since they reach ·06 m. m. in length, and ·02 m. m. in width. It is probable that some young distorted shoots of *Abies Smithiana*, collected at Mahasu, Simla, at an elevation of 8,000 feet, sent to me by Mr. J. S. Gamble (No. 4469), belong to this species; but the parasite was in a young state, and the spores were not formed, so that it is not possible to determine it with certainty. The habit is so different from that of the other two species from the Himalayas, that the unaided eye would at once distinguish them without resort to the microscope.

Peridermium abietinum, A. & S., is very little known, but the description agrees so well with that of *P. decolorans*, Peck., on leaves of *Abies nigra* in the United States, that

there is no difficulty in recognizing them as one and the same species. It is said that there are yellow indefinite spots which usually discolor the whole leaf; the peridia are roundish and white, soon ruptured and lacerated at the apex, spores are large and yellow, with a thick spinulose epispore. The size of the spores, which are nearly globose, is about ·035 m. m. in diameter. The trees, when attacked, acquire such a yellowish hue that they may be distinguished at some distance. In this species it has also been remarked that the peridia are accompanied by the little black dots which are scattered about the leaves as in the other species. Albertini and Schweinitz first found this fungus on the leaves of *Abies* in Europe, but so rare is it that it had become doubtful whether it was a true *Peridermium* at all, until it seems to have been refound in the United States, which fully confirms the accuracy of the original figures and description, affording another instance of the disappearance of a plant for very many years, and its re-appearance in some locality remote from its former habitat. Like instances are not rare in the history of plants.

Peridermium Ephedri, Cooke, is the one exception to the species being confined to strict *Coniferæ*, this having been found on slender twigs of *Ephedra antisiphilitica* in Texas. It was described by Beiheley and Curtis as a variety of *Peridermium pini*, but is quite different in appearance from either of the forms long included under that name. The peridia are small, surrounding the twigs, and growing in company, in long patches extending over several inches, looking more like a species of *Æcidium* than a *Peridermium*. In our specimens, which are rather old, the peridia are poculiform, with the margin irregularly toothed or ragged. The spores are almost globose, with a tendency to become angular as the result of compression about ·018 to ·02 m. m. in diameter. The epispore is more delicately and minutely roughened than in any other species. The form of the peridia, their mode of growth, and the very delicate markings of the small spores are features which will distinguish this from any other species. Up to the present this has not been recorded from any other locality than Texas in North America. It has been included here in order to render the

enumeration of *all* the species complete, and with it terminate the yellow-spored forms.

Peridermium balsameum, Peck., on leaves of *Abies balsamea* has at present been found only in the Adirondack Mountains in the United States. It is described as occupying the lower surface of the leaves, which are bleached wherever the parasite makes its appearance. The one feature which, more than any other, would distinguish this species from its congeners, is the globose white spores, about ·025 m. m. in diameter. It seems only to attack the young trees.

This completes the enumeration of all the species of *Peridermium* which are at present known, as far as I am aware, only three of which are yet recorded from India, and for the knowledge of two of these I am indebted to the good offices of gentlemen connected with the Forest Department. With such a good commencement it is to be hoped that through the same channel we may become acquainted with others of the fungoid parasites, which I doubt not are as common on the Forest Trees of India as of any other country.

INDIA MUSEUM, LONDON, *August* 1877.

Eucalyptus rostrata at Lucknow.

Extract from a Report by Dr. E. Bonavia *on the Horticultural Gardens at Lucknow, for the year ending the* 31*st March* 1877 :—

Para. 16.—The *Eucalyptus rostrata* still maintains its good character as one of the species adapted to the plains of India. The old trees produce flowers but do not appear to mature seed. This tree bears cutting without harm : it throws out new shoots readily, which soon replace the cut wood. It therefore appears useful for plantations, as cutting only regenerates the tree, and so the necessity of replanting is avoided.

The small plantation of this *Eucalyptus,* which I formed in the rains of 1875, is thriving admirably. During the hot months of 1876 it did not receive a drop of water by irrigation. The heat during that period was as follows :—

The means of the maximum temperature in the sun's rays were in—

April 1876	...	...	...	156°
May 1876	...	...	...	151°
June 1876	...		...	159°

The highest maximum was 175° in June, nevertheless the plants continued to flourish and to make vigorous growth. Now they are between 20 and 25 feet high, and are making new growth as the hot weather advances.

Last year I made two other small plantations of the *Eucalyptus rostrata* on soil different from the above and on higher ground. They are both on the same sandy soil without being specially manured. The first is on ground lately occupied by a *Casuarina* plantation; 650 of them were planted out in August and September. Many of them were five and six feet high, and most were three feet high when transplanted; and, although a good deal of damage was done to their roots, only 66 died, and 170 suffered by transplanting, that is, they dropped their leaves, but threw out new ones later. The majority did not suffer by transplanting at this season. On this same plot I put plants of a younger batch which were 18 inches high at the end of August. Of these not one died.

The older trees were purposely treated without care to find out how much ill-treatment they would bear. The whole plantation is now in good condition, and the plants average five and six feet high, and are making new growth. The ground of the second plantation was also occupied by young forest trees. No manure was used. It was planted in October; the plants were younger, and out of 225 only 15 died. They now average four feet, and are making new growth. In September 1876, availing myself of a cloudy day, I sent 100 *Eucalyptus rostrata* by rail to Dr. Condon for the Memorial Garden at Cawnpore. They were about 18 inches high, and each ball of earth was packed in 'munj' grass. On the 25th September, Dr. Condon stated "they are all doing well, some never drooped at all, and none very much." I have not been able to get any information how they have been doing since September 1876.

I tried sowing the seed in the rains, but the dampness kills the seedlings before they make any growth.

I also tried sowing it in the beginning of the winter, but the cold prevents the young seedlings from making any growth till the warmth returns.

The best time I find for sowing the seed is the beginning of February and March. The seed then germinates quickly and the seedlings make rapid growth. By April they can be pricked out into small pots or into a nursery, and when a foot or 18 inches high, they can be planted out permanently, where they are to remain. This size will admit of their being planted out just before the rains commence, so that not much labour will be needed afterwards for watering them. After a year's growth, experience has shown that they can stand the hottest weather and flourish without watering. Every additional growth after 18 inches makes it somewhat risky to transplant them from a nursery.

The tree in the Wingfield Park, specimens of which had been sent by Government to Kew, and was identified there as *Eucalyptus resinifera*, is, in appearance, totally distinct from the one we call *rostrata* in the horticultural garden. The latter grows rapidly, is very tall, does not spread, and sheds its bark. In September it had only flower buds. The former is of slower growth, is more spreading, is less tall, and does not shed its bark. In September it was in full flower and had many half-developed capsules. The *Eucalyptus resinifera* in the Wingfield Park is said to be about 10 to 12 years old. It is about 45 feet high, and is three feet nine inches girth at three feet from the ground. Seedlings of *Eucalyptus resinifera* raised from acclimatized seed and planted on similar ground in the Wingfield Park in November 1874, were in October 1876, one, about five feet, and the rest two to three feet high. The largest tree of *Eucalyptus rostrata* in the horticultural garden is between 60 and 70 feet high, and is about 12 years old. It is five feet girth at three feet from the ground. The young plants of *Eucalyptus resinifera* have a red stem and red edges to their leaves. The bark of the old tree is rough and very different from that of the *Eucalyptus rostrata*; the seeds are oblong, wedge-shaped, and many-sided.

I planted a few young seedlings of *Eucalyptus resinifera* in the horticultural garden raised from acclimatized seed. They are about two years old. Two are about 12 feet high and are growing vigorously, and the remainder, although of the same age, are only three and four feet high, and are not making any vigorous growth as yet. Probably a difference in the soil may be the cause of their different vigour. Baron Von Müller says of this species (*resinifera*) that its wood is much prized for its strength and durability, and the tree has proved one of the best adapted for a tropical climate.

In January 1876, I sent a packet of seed of *Eucalyptus rostrata* to each Deputy Commissioner in Oudh for trial in their district, with directions for sowing, &c., but little or nothing has come of it. Only the Deputy Commissioners of Sitapur, Gonda, Sultanpur, and Partabgarh can give any account of the seed sent to them. I also sent seed to many other persons, but only the following have succeeded in making anything out of them :—

Mr. Pearsale, of Nahun, states that the seed germinated in profusion. The plants were treated without care, and several were saved and are thriving. He thinks the *Eucalyptus rostrata* will do at that altitude, 3,057 feet. Those transplanted in the rains mostly suffered. One transplanted in the winter did not suffer at all.

Mr. Bellairs, Chowkoree, 5,000 feet high, states that the seed germinated well, but does not appear to thrive. The *Eucalyptus globulus* does better there.

Mr. Thomson, of Kooshtea, states the seed germinated and the plants are thriving. Mr. Pillans, Phoolbharrie Tea Estate, Silligori, Bengal, says that the *Eucalyptus rostrata* is doing very well indeed. He sowed a portion in July in boxes and then planted them out. Of these he has about 150 plants averaging 4′ and 4′ 8″ high. The second portion was sown quite after the rains. Of these he has about 200 plants, averaging two feet in height, are very healthy, and are growing fast.

Captain J. F. Miller, Roopur, states that the *Eucalyptus rostrata* germinated well. The seedlings were planted out in the rains, and, in December 1876, averaged 4½ feet. One was

7 feet. The best were on a bank 20 feet high, composed of shingle and sand exclusively.

All others state that the seed either did not germinate at all, or that it germinated and the plants withered while young; and I have little doubt that this was from want of management, as the seed was of the same lot which succeeded elsewhere.

The new kinds of Eucalypti, which I have tried during the past year, are *Eucalyptus cornuta* and *Eucalyptus sideroxylon* or *leucoxylon*. I have some hope that both these will thrive in the plains, especially the *Eucalyptus cornuta*. When young, the latter has a light green emarginate leaf, and is different in appearance from the other Eucalypti I have tried. It resembles more that ticketed *colossea*, but the latter has a *pointed* leaf. Of this kind (*cornuta*) I have alive 111 plants. They average eight and ten feet in height, and are all more or less in a vigorous condition. They transplant well, even when three and four feet high. Of the *Eucalyptus sideroxylon* I have 88 alive, most of them are healthy; as a rule, they don't make rapid growth, and they don't appear to transplant very well at three feet high in the rains. Some were transplanted when two feet six inches high in the beginning of September, and several of them suffered; others of the same height, transplanted in the beginning of August, did not suffer. The seeds of these two kinds I procured from Baron Von Müller, and I, therefore, think they are rightly named. Three other kinds procured also from him, and tried for the second time, *viz.*, *Eucalyptus fissilis, obliqua*, and *marginata*, did very badly.

Baron Von Müller has lately sent me the following new kinds, which are now undergoing trial:—

Eucalyptus pilularis,
" *viminalis,*
" *polyanthemos,*
" *Stuartiana,*
" *melliodora,*

besides more seeds of *Eucalyptus cornuta* and *sideroxylon.*

I also obtained the following new kinds from Mr. Cresswell of Melbourne:—

Eucalyptus cordata,
" *concolor,*

Eucalyptus robusta,
,, *Gunnii,*
,, *longifolia,*
,, *paniculata,*
,, *hemiphloia,*

and *Eucalyptus citriodora* from the Queensland Acclimatization Society.

I have also under further trial a number of seedlings from acclimatized seed of the *Eucalyptus resinifera.* The old tree in the Wingfield Park gave a larger quantity of seed this year, which the Superintendent forwarded to the Deputy Commissioner for transmission to Government.

RESOLUTION.

His Honor the President in Council has noticed with satisfaction the continued success of the cultivation of two species of Australian Eucalypti at Lucknow, and desires that Dr. Bonavia's remarks on the subject be communicated to forest officers and others interested in arboriculture. A late communication from Professor Oliver, the Keeper of the Royal Herbarium, Kew, to the Inspector-General of Forests, states that specimens of the trees in the Wingfield Park, Lucknow, hitherto named *Eucalyptus resinifera,* have now been finally identified as *Eucalyptus saligna,* Smith, a tall tree from New South Wales, where it is known as White or Grey Gum.

Memorandum on the Conolly Teak Plantations at Nelambur, Malabar District.

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By ATHOLL MACGREGOR, M.C.S., *late Collector of Malabar.*

THE Nelambur Teak Plantations were first suggested in 1840 by Mr. Conolly, Collector of Malabar, who described their object as being "to replace those Forests which have vanished from private carelessness and rapacity—a work too new, too extensive, and too barren of early return to be ever taken up by the native proprietor."

Great difficulty was at first encountered in getting the seed to germinate, and many expedients were resorted to. It was argued that in the natural forest the hard outer covering of the seed was destroyed by the annual fires, and it was sought to effect the same object by covering the seed with a light coating of dry grass and setting fire to it. Soaking in water was also tried. In the one case the heat destroyed the vitality of the seed, and in the other the seed rotted. Removing the husk by hand was also tried, it being suggested that it was only the seeds in the forest which happened to be cleaned by white ants that germinated.

The transplantation of self-sown teak saplings had been simultaneously tried, but whether from injury to the trees in removal, or from attempting to grow too much under shade, or too near mature Teak that had already exhausted the surface soil so far as regarded the constituents of teak, this also proved a failure, and Mr. Conolly, in a letter of 4th August 1842, reported that of 30,000 seeds sown none had come up, and that of 10,000 saplings transplanted more than half had died. Recourse was next had to a Mr. Perrotet, a French gentleman, Superintendent Botanical Gardens at Pondicherry. His advice was to plunge the seed in water nearly boiling, and to uncover the roots of old stumps and cut them in places in order to cause the development of shoots; this experiment came no nearer success.

The true method appears to have been first suggested by Dr. Roxburgh at the end of 1843. He advised sowing the seed at the beginning of the rains in shaded beds lightly covered with earth and rotten straw. The present method is given in an appendix, and it will be seen that 30 years have added little to the knowledge acquired in 1844—for except that the seed is sown 2 months before the rains, and artificially irrigated so as to give it an additional start the method is substantially the same.

Writing in 1844, Mr. Conolly described the experiment as at an end, and success achieved owing to the extraordinary healthy appearance of the young seedlings, 50,000 of which were raised in May, June, and July 1844.

The marginal statement gives the area planted annually arranged in periods of 10 years, and the accompanying map indicates the blocks, a carmine wash showing 1st period, a vermilion wash the 2nd period, and a burnt sienna wash the 3rd.

Years.	Acres.	Years.	Acres.	Years.	Acres.
Up to 1844	31	1853	55	1863	81
1844	63	1854	92	1864	121
1845	61	1855	100	1865	56
1846	100	1856	79	1866	128
1847	118	1857	36	1867	118
1848	182	1858	42	1868	145
1849	134	1859	39	1869	53
1850	132	1860	39	1872	235
1851	147	1861	86	1873	86
1852	38	1862	50	1874	84
10 years.	1,006	10 years.	617	10 years.	1,107
Yearly average	100		61		110

The years 70 and 71 are not represented, operations having been carried on elsewhere. The statement shows that up to 1874 the area planted in this section aggregates 2,730 acres, or an average of 91 acres per annum for the 30 years.

The Nelambur valley is of the shape of a horse shoe, and is elevated about 400 feet above sea level. The hills surrounding it on three sides rise in the direction of Sisapara on the S. E., and the Camel's Hump on the N. W. to 8,000 feet, while to the N. E. the plateau of S. E. Wynaad, which closes it in on that side, does not attain an average elevation of more than 3,000 feet. The semicircle of hills overhangs one vast amphitheatre of valleys of denudation converging on Nelambur, and a great part of the Valley, including almost always the river bank to a distance of several hundred yards, is an alluvial deposit of enormous depth; the rocks are described by Mr. King as Gneiss of quartzo-felspathic or quartzo-hornblendic variety.

Rainfall on slopes of surrounding ghauts is probably over 200.

The rainfall is about 120 inches, falling chiefly between June 1st and November 1st. The temperature in shade ranges from 80 to 90 throughout the year, and there is a singular absence of high wind all the year round.

The rivers are navigable by rafts up to January, and below Mambat, the most westerly point of the Plantation, the navigation is so easy that the largest rafts can be managed by one man. The river which drains the valley empties itself into the sea at Beypore, and 4 miles from the mouth of the river a navigable canal communicates with another river which tra-

verses the heart of the Calicut Bazaar, the best timber market on the west coast. This river is connected with the Calicut roadstead by a bar always open, so that the cost of conveying timber from the Plantations alongside ship may be regarded as at a minimum.

A good cart road is carried from Calicut through Nelambur up the Carkoor Ghaut to S. E. Wynaad, whence the main line is carried on to Mysore, with branches on the north to the Devala gold fields and south Wynaad, and on the south to the Ouchterlony Valley and to Ootacamund. The road skirts the plantations for 6 miles, having bridges over the two large rivers.

The climate of Nelambur is tolerably healthy throughout the year. The months of March, April, and May are the fever months, but with due precaution fever is seldom contracted at Nelambur itself.

Forests in Malabar are private property and the great bulk of the land in the Nelambur valley is the property of the Nelambur Rajah or Tirumulpad, a wealthy landowner not likely under any circumstances to sell land, still less for the purpose of instituting a local industry of a character to compete with his own agricultural and timber operations for the limited supply of local labour. The plantations owed their existences to the accident that one of the many religious bodies holding temple lands happened to be in want of funds and to own blocks of land scattered here and there in this valley, many of which constituted the very best sites for planting that could have been selected had the whole area been available to choose from.

In considering, however, the difficulties which had to be contended with, it is necessary to regard as occupying a prominent position, the jealousy of a local Rajah of overpowering influence whose Palace aud Pagoda formed the only point of social attraction in what was otherwise a jungle.

The maps indicate the successive directions in which efforts were made. At first, operations were confined to the narrow strips of river bank, west of Nelambur, and when in 1853 these appeared to be exhausted, a point to the east, further up the river was selected, and became the scene of the operations of

that year as well as of 1855 and 1856. The mistake was, however, made of including in the planted area several laterite hills over which the trees signally failed.

Accordingly attention was again turned to the lands down stream, and in the vicinity of the earlier plantations on the north bank land was found yielding sites for 1857—1862, inclusive of fair quality, some being very good. In 1860, however, exploration had been set on foot further up stream than had hitherto been attempted, *i.e.*, above the junction of the Shurly River with the Karimpoza or main stream. Here there were found several pieces of land included in the Government Estate, with first class soil and water carriage which formed a compact block adapted for further extension on a larger scale. In 1863 Mr. Ferguson arrived, bringing the knowledge of a forester trained in the extensive plantations of Perthshire, and operations were vigorously prosecuted for the ensuing 7 years, *i.e.* from 1863—1869, by which time 619 acres had been planted in this quarter as indicated in the map by a burnt sienna wash. The area of suitable land here having been exhausted, the experiment was made of further extending at Nellikutta, 10 miles up stream and near the base of the hills, and here in 1870 and 1871 rather more than 100 acres were planted.

The site, however, proved so unhealthy that it was abandoned owing to loss of life and invaliding among the establishment. Fortunately at this time an opportunity presented itself of acquiring by purchase a block of land containing some superior planting sites, and almost surrounded by Government land planted or in forest. Here operations have been carried on since. In order to make up for the break of continuity caused by the plantings of 1870 and 1871 having been carried out at a site that had to be abandoned, 235 acres were planted in 1872 so as to bring up the average to 80 acres for the 3 years, which average was maintained during 1873 and 1874.

During these last two years operations had been carried on simultaneously at the newly-acquired site at Amrapolliam, so as to open up a different source of labour-supply through the village of Wandur, and create a basis of operations for further extension at the Karimpoza site. It is, however, not advisable

to go further into these particulars, but to confine observations to the area already described, amounting to 2,730 acres, the object of this paper being to investigate the actual position of the undertaking, with reference to the ascertained survey areas.

To determine the success of the enterprise the questions to be asked are: What have the plantations cost? What do they now return? What are they likely hereafter to return?

Taking as a basis the calculations made in 1872 at the suggestion of Major Pearson, and adding the subsequent cost, the total outlay on the plantations is Rs 2,29,000,* of which since 1863 a sum of Rs. 1,01,000 has been recouped by thinnings, leaving the net cost Rs. 1,28,000. The opponents of planting, however, *maintain that up to the period when interest is returned* the cost must include compound interest at 4 per cent. on the original outlay.

As a matter of pure calculation of financial results this must be conceded, without, however, admitting that on the showing of absolute profit thus computed is to depend the question of whether a certain portion of the Forest Revenue is to be returned to the land in view to reproduction of timber.

This includes payments for land, *viz:* in 1840 for lease from Pagoda Committee Rs: 9,000, and in 1871, for Chatamburia planting site Rs. 5,000.

If the net expenditure of each year is taken and calculated up to 1874, at compound interest, the debt against the plantations amounts to Rs. 2, 35,000.*

To estimate fairly the position, annual extensions must be kept out of sight, and the capital account closed. In 2 or 3 years there would be no very young plantations unable to take care *of themselves and entailing, therefore*, heavy expenditure. The future outlay will then be restricted to fire-tracing, clearing parasites, watching and thinning out of saplings.

A third of the existing establishment might be debited to the plantations, leaving the remainder to be divided between the natural forest operations, and extension of plantations on new site.

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* Labour has cost 4 annas a day for many years. In the earlier years the cost was less. It may be roughly estimated that at present rates planting costs Rs. 30 an acre—felling, burning, pitting, planting, and once weeding, nurseries and establishment being included.

Altogether an annual expenditure of Rs. 5,000 would probably suffice.

An annual revenue *from thinnings of* Rs. 10,000 *would thus* cover the upkeep, and pay 4 per cent. current interest on the actual outlay; and the question is, do the facts lead to anticipate a steady income of this amount?

The actuals derived from the sale of thinnings have been as under:—

		Rs.
1863	...	12,044
1864	...	1,216
1865	...	16,776
1866	...	9,307
1867	...	15,647
1868	...	500
1869	...	9,515
1870	...	4,173
1871	...	5,583
1872	...	843
1873	...	7,378
1874	...	11,162
12 years	...	94,144
Per year	...	7,845

The period from 1868 to 1872, inclusive, shews a falling-off. This may be partly accounted for by the fact that in the first year or two, owing to previous neglect of thinning, the return may have been abnormally large.

A further explanation will be found in the fact that at about 10 years of age a plantation begins to yield profitable thinnings, and that if the old years' figures be scrutinized, it will be observed that the years that supplied annually to each of these 5 years a plantation for the first time yielding profitable thinnings were those in which a marked diminution in the average area of extension is apparent. Thus the acreage planted, 1858—1862 inclusive, was only 256 acres, or an average of about 50 acres compared to an average of 100 in the earlier period.

During the next 10 years, on the other hand, the annual acreage that will come under thinning each year is 110, and

when in addition to this, allowance is made for older plantations requiring thinning for a 2nd or 3rd time, there seems a fair *ground for anticipating a gradual increase of income from this* source.

The following table shows the classification of thinnings for the market :—

Class.	Average Diameter.	Average Length.	Estimated yield.
	Inches.	Feet.	Rs. A. Rs. A.
Superior.	3½ to 4	30 to 40	1 0 to 4 0
1	2½ to 3	30 to 45	1 0 to 2 0
2	2 to 3	30 to 40	0 12 to 1 4
3	1½ to 2	20 to 35	0 6 to 0 12
4	1 to 1½	15 to 30	0 1 to 0 8

During the last few years some saplings have been annually brought to market realizing from Rs. 5 to 10 each. This class must undoubtedly increase in number rapidly, as the plantations increase in age, and here a few remarks may be appropriately introduced as to the system that has hitherto guided the selection of trees for thinning. The idea of revenue has been entirely and most wisely ignored, the number removed being decided solely with reference to requirements of space and light, inferior trees being invariably, if possible, removed in preference to superior.

The original planting may be reckoned as giving 1,100 trees to the acre, of which a considerable number never make any show, being dwarfed in the first 3 or 4 years by exceptionally vigorous neighbours, or perishing from other causes.

The first thinnings are not worth removal. The trees remaining per acre at 10, 20, and 30 years may be roughly stated at 750, 500 and 150 respectively.

Thus each tree in a 30 years' old plantation represents a selection, partly natural, partly in accordance with principles of forestry of 1 in 7.

The further reduction that will ensue is a matter of somewhat uncertain conjecture ; but, if a final crop is taken at 80 years old, a clean cut being then made, block by block, it is estimated that the trees would be of a size to admit of not more

than 50 to the acre, so that 100 trees per acre would be obtained from a 30 years' old plantation before the final crop was taken—timber that would be suitable for minor building purposes, for sleepers and for bridge work of a certain class.

The finding of a market for the ordinary thinnings of the classes before noted is an important consideration, and on the success with which the thinnings are brought to market at the right period and judiciously disposed of, the income from this source greatly depends.

There is a limit to the extent to which this class of materials can command a local market, and it is only the exceptional demand at Calicut that has hitherto admitted of so large an income being obtained. Calicut is a great *entrepot* for the trade of the Persian Gulf and Arabian Ports, and a demand for poles and minor building materials is naturally great from these rainless regions, not to mention the demand for materials so suitable as these are for the rigging of Native craft.

As years advanced, of course, the numbers of the thinnings of the smaller classes would decrease; but, on the whole, it is probable that, taking into consideration the increase in the larger *timber annually removed*, the revenue would at least maintain itself at 10,000, and thus simple interest and working expenses be secured till the final crop was realized. It is even likely that this amount may be largely exceeded, and any excess will be so much towards extinguishing the debt.

Captain Seaton, whose estimate is the most careful and business-like of any I have yet seen, calculated the final crop at 100 acres a year, of 50 trees to the acre and 50 cub. ft. to the tree, and taking the rates realized at Rs. *1, 1½ and 2 a cub. feet* he shewed a profit of Rs. 40 per tree, or 2 lacs annually.

The figures given in this report show that the average area planted annually for the 30 years has been 91 acres, and from this a deduction is necessary to cover spaces, where from some cause or another there has been failure, or where hereafter failure may occur. Looking at the long period of time that is to elapse, the area may, from this cause, be reduced nearly 25 per cent., say to 70 acres. The yield per tree of 50 cub. feet seems a moderate estimate, considering that exceptionally fine trees

might now be pointed out in parts of the older plantations containing more than half that quantity.*

Supposing the average price to be 1—8, a net profit of Rs. 40 leaves Rs. 35 for expenses, or 11 annas a cub. ft. This, if applying merely to felling and floating, is excessive, as it is well known that inferior woods, fetching no more than 4 and 5 annas a cub. ft. in the Calicut market, are profitably removed from forests further up the same rivers, and consequently more expensive to work.

Establishment charge, too, would dwindle to a very small figure per cub. ft. over such extensive operations.

It is doubtless safe to allow a wide margin in such calculations, but here there is sufficient to cover not only large excess in cost of operations, but also a falling-off in the number of trees per acre or in the price realized.

Regarding this last it seems very improbable that at such a distant date, when it may be presumed the natural supply of timber in the market will have so much diminished, an average rate of Re. 1½ per cub. ft. will not be realized by teak of the clean, straight, sound growth, for which the Nelambur Valley teak is celebrated, a character which in the plantations promises to be fully maintained.

Colonel Beddome's apprehensions that the quality of the timber will be found in a considerable degree inferior in the market to Annamullay teak does not seem well grounded,† especially when the absence of heartshake and the economy of working secured by straight growth is considered. A comparison of the conditions under which the two classes of timber can be brought to market shews what a hopeless disadvantage the Annamullay teak labours under.

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* Mr. Stanborough, Assistant Conservator, took measurements in 1874, and calculated on them an average of 1,500 cub. ft. per acre of timber in the plantations of 1844—1853, inclusive—the maximum of a year being 2,500 and minimum 1,350. Further measurements and calculations are desirable.

† Here and there natural teak trees have been left standing, to the great detriment of saplings planted near them. They are from time to time felled, and a batch of such logs was seen by Col. Morgan, Conservator of the Mudamullay Teak Forest, and Mr. Douglas, Conservator of the Anamullies, while inspecting in 1872. A fair sample of the batch was judged by these two competent authorities to be some 60 years old, and to contain 50 cub. ft. of timber worth, from its even growth and quality, Rs. 9 a cub. ft. in the market depôt to which Rs. 5 or 6, would suffice to transport it.

Speaking of the latter, in a letter dated 14th May 1875, No. 128 (G. O. Madras Government, Public Works Department, 6th July 1876), Captain Campbell Walker observes that he doubts whether Re. $1\frac{1}{2}$ a cub. ft. for timber delivered in Coimbatore leaves any profit to the department, and Colonel Beddome, under date 19th April 1876 (*vide* same proceedings), wrote that it was very evident that those rates could not be remunerative or even cover working expenses.

In other words, the Annamullay teak, despite its excellent quality, can scarcely be brought to market for the market value owing to the absence of perfect water communication between the forests and market depôt. Hitherto the use of teak generally for bridge work has been on the west coast greatly discouraged by the difficulty of securing with certainty and with no very long notice a large number of beams of the necessary scantling, and hence either inferior sorts of timber are used or iron girders imported.

With these compact areas to work on, and the great number and uniformity of growth of the trees, it may be fairly expected that teak for bridge-work will be much more extensively used when the plantations begin to mature their crop.

It must be freely admitted that all calculations of this nature are liable to error, but making all allowances it seems impossible to resist the conclusion that eventually the result of the plantations must be to contribute to the wants of the country an immense stock of useful material, realizing such a revenue as fully to reimburse the State for their outlay even after compound *interest for the unproductive period* is allowed. This result must be deemed a satisfactory outcome of the exertions of Mr. Conolly, the zealous pioneer of the enterprize, of the late Chatoo Menon, the native Conservator, who for 20 years carried on the operations, and of Mr. Ferguson, whose skilled and unremitting attention during the last 14 years has brought the plantations to their present pitch.

APPENDIX.

A.—*Memorandum on growing Seedlings from Teak Seed, Planting out, &c. by Mr. J. Ferguson, Deputy Conservator of Forests, Nelambur.*

1. Collect seed from trees with a clear stem free from decay and of vigorous growth; February the best month to collect in.

2. *Preparation of Nursery Beds.*—Select good free soil, dig 12 inches deep, removing weeds, roots, and stones When caked, the soil should be reduced to a fine mould, and the nursery levelled; line off beds, 3½ feet wide and one foot space betwixt each bed and its fellow, then raise an outer edging round each bed, 3 to 4 inches high; beds when thus finished will be about 2½ feet wide between the edgings, and 120 seers of seed will suffice for 150 feet in length of the above-sized beds; sow from 10th to 15th April; before sowing steep the seed forty-eight hours in water, then sow and cover with a thin covering of fine soil, nearly ¾ inch, then cover with straw to retain the moisture; betwixt the soil and straw a few very small twigs without leaves to prevent the straw from being washed into the soil by water; which, if allowed, is apt to destroy the young seedlings on its (the straw's) removal. Water daily copiously, say a common earthen pot of water to each two running feet in length of bed, less or more, according to free soil, or otherwise; in this way the seed will germinate in from 10 to 15 or 20 days, or more, according to freeness of soil; water less as the plant strengthens, but keeping up sufficient moisture till the monsoon sets in from the 1st to the 3rd week in June, when the plants will be from 4 to 8 inches high and ready for planting out permanently.

3. The site for planting should be selected and felled in December, allowed to dry till March, fired, then cross cut, piled, and burned off, and after the soil is softened by the rains, line and mark off the pits the required distance apart; from 6 to 7 feet answers well, the pits dug from 10 to 12 inches square, and equal depth and filled in as dug with earth slightly raised around tops.

4. *Planting.*—The seedling should be put well down in the pit, taking care the tap root is not twisted and turned up (to prevent which the tap root is shortened to 6 inches as lifted from the bed); when planting the cooly inserts his hand the required depth perpendicularly, taking out the soil and putting the seedlings with the other hand (as above without twisting or turning up the root), putting back the removed soil and pressing it firmly round (without damaging) the plant, and this prevents its being wind waved before taking root.

5. Planting should take place after the soil is well saturated with rain; from the 10th to 30th June and 8th July is the best season, as afterwards the seedling's tap root rapidly swells like a carrot and does not throw out fibrous roots, nor establish itself either so quickly or so well as before that state of growth.

When the planting cannot be finished by the 8th of July, the small vigorous seedlings, which continue to germinate up till August and will even germinate after twelve and fourteen months in the beds, should be selected in preference to the larger and more robust with the carroty roots.

NOTE BY THE OFFICIATING *INSPECTOR.*

I am informed by the Conservator of Forests, Southern Division, Bombay, that he has tried transplanting Teak Seedlings in the nursery before planting out, with the best results, and as this plan mitigates the difficulty to which Mr. Ferguson refers with regard to the long carroty roots, it appears worthy of trial where circumstances admit. The Conservator of Forests, Southern Division, Bombay, has promised a memorandum on the subject which will be circulated on receipt.

(Signed) C. WALKER, CAPT.,
Offg. Inspector of Forests.

OOTACAMUND,
26*th March* 1874.

B.—*Memorandum on Planting expenses, by Mr. J. Ferguson, Deputy Conservator of Forests, Nelambur.*

Cost per acre of Planting natural Forest.

	Rs.	As.	P.
Weeding undergrowth preparatory to felling	2	0	0
Felling	6	0	0
Firing the jungle as first felled	0	4	0
Cross cutting remains of first burn	8	8	0
Piling and burning off clear...	10	0	0
Lining, marking, pitting and planting out	8	8	0
Weeding and hoeing round the plants	2	8	0
2nd Weeding	1	4	0
3rd Weeding	1	4	0
4th Weeding	1	4	0
Teak seeds 2 parrahs	0	8	0
Preparing, sowing and watering nursery beds	8	0	0
Contingencies	2	0	0
Total ...	36	0	0

Cost per acre of subsequent Maintenance.

	2nd Year.			3rd Year.			4th Year			5th Year			6th Year.		
1st Weeding ...	2	8	0	1	8	0	1	0	0	0	12	0	0	12	0
2nd Do	2	8	0	2	4	0	1	12	0	1	4	9	1	4	0
3rd Do.	2	8	0	2	0	0	1	4	0	1	0	0	0	0	0
4th Do.	2	8	0	0	0	0	0	0	0	0	0	0	0	0	0
Pruning	„	4	0	0	8	0	0	8	0	0	12	0	„	12	0
Total ...	10	4	0	6	4	0	4	8	0	3	12	0	2	12	0

The above rates are for plantations formed from old natural forests, and should meet all charges on ordinary soil exclusive of superintendence.

If the soil is very fine, and has been previously cropped more than once, the cost of felling and burning will be reduced, but the cost of weeding will be increased for the 1st, 2nd, and 3rd years, but as the plants begin to cover the ground the undergrowth decreases considerably.

If the plantations are intended for 1st class timber the thinning should begin from the 6th or 7th year.

Government of Madras, Revenue Department.

Enclosure No. 1.—*Copies of Memorandum on Conolly Teak Plantations.*

Mr. MacGregor's memorandum on the Conolly Teak Plantations will be submitted to Government with reference to paragraph 17, G.O., dated 29th April 1874, No. 503.

2. The Nelambur Teak Plantations were first fairly started in 1844, and the area planted in the thirty years ending with 1874 amounts to 2,730 acres, or an average of 91 acres per annum; they are situated on the bank of the river which discharges itself at Beypore, and as the navigation is stated to be easy, the position affords great facilities for the conveyance of the timber to the coast; there is also a good cart road connecting the valley with the Wynaad and Mysore.

3. The total outlay on the plantations from the commencement is given as Rs. 2,29,000, of which Rs. 1,01,000 have been recouped by thinnings since 1863, making the net cost Rs. 1,28,000, but it is not clear whether the computation is made up to the close of the official year 1873-74, or the calender year 1874. If compound interest at 4 per cent. on the original outlay be taken into account, the debt against the plantations is stated to amount to Rs. 2,35,000, Mr. MacGregor deals only with the plantations opened out up to the end of 1874, and considers that they should be separately treated, extensions being kept out of sight, in order to form a fair estimate of the position. The annual expenditure on establishment and upkeep is set down at Rs. 5,000, on the supposition that it will be fair to debit one-third of the existing establishment to the plantations already formed, the remainder being divided between extensions and conservancy of natural forest. The annual revenue from thinnings is estimated at Rs. 10,000, the actuals during the last twelve years, previous to which there was no return, giving an average of Rs. 7,845 per annum. Mr. MacGregor considers that he is justified in anticipating a gradual increase of income, as a larger acreage will be brought under thinning in future years than has been the case in the past; second and

third thinnings must be taken into consideration, and the size of the saplings and timber removed year by year will increase. Taking these assumptions to be warranted, there will be an annual surplus of Rs. 5,000, which will, Mr. MacGregor states, pay "4 per cent. current interest on the actual outlay;" but it is not explained why the whole of the returns up to 1874 should be appropriated to the reduction of the capital outlay, not even simple interest being secured to Government during the first period of thirty years. Correctly speaking the surplus will amount to little more than 2 per cent. on the actual outlay.

4. The eventual returns are calculated thus:—The teak will come to maturity in about fifty years, and a clean cut will then be made, the trees being, by that time, probably of a size to admit of not more than fifty to an acre; each tree is calculated to yield on an average 50 cubic feet of timber, the average price being taken at Rs. 1-8 a cubic foot; and allowing 11 annas a cubic foot for the expense of felling and bringing the wood to market, a net profit of Rs. 40 per tree is relied on. The area of the plantations is 2,730 acres, and allowing a reduction of 25 per cent. for unporfitable areas, Mr. MacGregor calculates that 70 acres will be available for felling annually, basing his estimate on the average acreage planted annually. Assuming Mr. MacGregor's figures to be correct, the plantations will yield for thirty years an annual revenue of Rs. 1,40,000 ($70 \times 50 \times 40 = 1,40,000$). There seems no reason to doubt that looking to the favourable site of the plantations and the denudation of private forests which is now going on, the timber will find a ready market fifty years hence, and ample allowance appears to have been made for every contingency, the deduction for unprofitable areas and for cost of bringing the timber to market appearing to be even in excess of what is necessary. The Board think that Rs. 1,40,000 may be safely taken as the annual income from 1,924 when the cuttings commence, till 1,954 when the last block will have been cleared.

5. To arrive at a conclusion as to how far such a return in prospect justifies the expenditure which is being incurred, it is necessary to ascertain what the cost of the undertaking will

have amounted to at the time when the revenue is realized; for though other considerations then the realization of such a profit as would be looked for in any commercial enterprise must influence the decision, it is expedient that the financial results should be estimated as accurately as possible on the principles which would regulate any commercial speculation to ensure that the operations shall not entail a dead loss. Mr. MacGregor has not given the details on which his calculations of cost are based, but he refers to the computation made in 1872 at the suggestion of Major Pearson, and it is presumed, therefore, that the figures given at page 133 of the Administration Report of the Forest Department for 1872-73 have been adopted. According to a calculation made in the Board's office, the debt against the plantations, including compound interest at 4 per cent. on the net expenditure in each year, and on the purchase money of the two sites, amounted at the end of 1873-74 to Rs. 2,15,272, the figures for 1873-74 having been taken from the Administration Report for that year. It seems, however, that the plantings of 1870 and 1871 have been excluded by Mr. MacGregor, and that he has added the areas planted in 1873-74 and 1874-75, the exact extent and cost of which cannot be gathered from the Administration Reports for those years. The Board are, therefore, unable to check the calculation; but assuming that the total outlay amounted to Rs. 2,35,000 in 1874, the charge will amount to Rs. 16,70,063 fifty years hence, including compound interest at 4 per cent. Setting off against this debt the annual surplus from thinnings of Rs. 5,000, with interest at the same rate, which will aggregate Rs. 7,63,325 in fifty years, the net debt will amount to Rs. 9,06,738 in 1924. Adding to this compound interest at 4 per cent. up to 1954 when the last block will have been cut, the total charges will amount to Rs. 29,40,936. The estimated receipts for cuttings at Rs. 1,40,000 a year from 1924 to 1954, *plus* the net receipts from thinnings during the period, after making allowance for the area cleared each year, will amount with compound interest to Rs. 80,14,191; thus leaving a balance of Rs. 50,73,255 in favour of the plantation. If the debt at the end of 1873-74 be taken at Rs.

2,15,272, as calculated by the Board, the balance in favor of the plantation in 1954 will amount to Rs. 55,27,953 instead of Rs. 50,73,255. In other words, the debt against the plantation will be cleared off in 1930 or 1929, and the subsequent net income from the plantation, with compound interest, will amount in 1954 to Rs. 50,73,255, or Rs. 55,27,953 ; the present value of which is Rs. 2,20,095, or Rs. 2,39,838, as shown in the statement below :—

Items.	Receipts.		Expenditure.	
	Based on Mr. Macgregor's *Figures.*	As calculated by the Board.	Based on Mr. Macgregor's *Figures.*	As calculated by the Board.
	Rs.	Rs.	Rs.	Rs.
Net expenditure up to 1873-74, including compound interest at 4 per cent.	...	...	2,35,000	2,15,272
Compound interest on the above from 1873-74 up to 1924	...	...	14,35,063	13,14,609
Total ...	...	...	16,70,063	15,29,881
Net receipts from thinnings from 1873-74 up to 1924, with compound interest	7,63,325	7,63,325	...	...
Net expenditure up to 1924 ...	...	...	9,06,738	7,66,556
Compound interest on the above up to 1954	...	...	20,34,198	17,19,682
Total ...	...	...	29,40,936	24,86,238
Net receipts from 1924 to 1954 with compound interest. 1. From cuttings at 1,40,000 a year	78,51,844	78,51,844	...	...
Net receipts from 1924 to 1954 with compound interest. 2. From thinnings	1,62,347	1,62,347	...	...
Total ...	80,14,191	80,14,191	29,40,936	24,86,238
Net profit ...	50,73,255	55,27,953	...	...

Paragraphs 103 and 104.

It seems, therefore, that the operations are likely to prove remunerative if the assumptions on which the above calculation is based be correct, but the Board observe that the Conservator of Forests states in his annual report for 1875-76 that any estimates as to the yield of these plantations and the profit per acre must be mere guess work, as nothing is known regarding the age at which Nelambur Teak will come to maturity, and the price which it

is likely to realize in the market, and that, though there can be no reasonable doubt that the plantations will, at some future date, yield a large permanent revenue, he is not sanguine on the subject of large profits. He considers that the mature timber standing should not be valued at more than 10 annas per cubic foot, whereas the rate adopted by Mr. Macgregor is about 13 annas a cubic foot.

6. It is very desirable that a regular account of all expenditure on each block or set of blocks constituting a separate plantation should be maintained from the outset, in order that the financial position may be ascertainable at any time. This seems especially necessary in regard to the extensions at Amrapolliem as the purchase money debitable to this portion of the plantations, *viz.*, Rs. 80,000, constitutes a heavy item. This sum would amount at compound interest at 4 per cent. to no less a debt than $18\frac{1}{2}$ lakhs of rupees in round numbers at the expiration of the period of eighty years required apparently to bring the teak to maturity, so that the returns must be considerable if a profit is to be realized from this portion of the plantation. The tract secured for the above payment was 4,500 acres of forest land for teak-planting, besides about 100 acres of planted teak averaging ten years' growth, on a lease for 999 years, subject to an annual quit-rent of Rs. 100. If the greater part of this area be planted up, and the demand for timber prove stable, a profit may, no doubt, be realized eventually; but with so heavy a debt on account of purchase money accumulating from the outset at compound interest, economy in working expenses will be necessary. Applying Mr. Macgregor's method of calculating the ultimate receipts to this tract, *i.e.*, deducting one-fourth of the area to cover failures, allowing fifty trees to the acre and Rs. 40 for the profit per tree, and supposing that one-eightieth of the area will be planted every year, and that the cuttings will be in the same ratio, the receipts from the plantation at the expiration of eighty years will amount to Rs. 86,000 a year, while the debt due to the purchase

G. O.'s, dated 2nd August, 12th August, and 9th September 1872, Nos. 1155, 1194, and 1,302.

Accurately Rs. 18,43,952.

43 × 50 × 40.

money alone on that date will have amounted to Rs. 18½ lakhs. This debt, with its compound interest, can only be discharged after 44 years from the date of the commencement of the cuttings, or 124 years from the commencement of the plantation. Carrying the transaction to the date on which the last block of the plantation will have been cleared, there will only be a balance of Rs. 49,04,638 in favor of the plantation from which all charges, other than the purchase money with their compound interest, will have to be met. It would, therefore, seem advisable that the Conservator should be called upon to frame as accurate a forecast of the probable financial results of the experiment as the means at his disposal will admit of, *before the Government are committed to a vast outlay which* may prove unremunerative.

7. The Board observe that Mr. Macgregor makes no mention of the terms on which the sites of the plantations reported on are held. The Trikalayur pagoda land was obtained in 1840 on mortgage for such term as the Government might wish to retain possession, subject to the payment of a stamp fee of 1 rupee on certain timber then standing, and of half a rupee on saplings in existence and on all trees thereafter planted by Government on "their becoming fit for cutting." A renewal fee of 20 per cent. on the mortgage money, *viz.*, Rs. 1,000 is also payable every thirty years. The land acquired in 1870 was obtained on perpetual lease on payment of a sum of Rupees 5,000 down and a stamp fee of 1 rupee per tree of measurable timber cut, saplings felled in thinning not being chargeable. It does not appear whether these items have been taken into account, nor whether any demand has been made for payment of a stamp fee on the saplings removed from the pagoda land. Difficulties might arise owing to the vagueness of the wording of the deed, and the position would be materially effected by any such claim, as it appears from the classification of thinnings at page 5 that inferior saplings are only worth from 1 rupee to 8 annas each.

See mortgage-deed forwarded with Collector's letter embodied in G O., dated 23rd November 1861, No. 2208.

(Sd.) C. A. GALTON,

Sub-Secretary.

III.—NOTES AND QUERIES.

Form and Manner of keeping the Cash Book.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—I shall feel obliged if you will kindly allow me space for a few remarks on the Departmental Cash Book as now ordered, for it appears to me that para. 107 of the Code, "all accounts must be kept in the most regular and open manner," *cannot* now be carried out.

The Cash Book (Form No. 14) has two columns—"Cash" and "Bank or Treasury" on each side. For my part I should prefer to have the columns "Revenue" and "Budget Grant."

In the "Revenue" column on the Dr. side would, of course, be entered all receipts of revenue, and on the Cr. side, all remittances to the Treasury or Book Transfers would be shewn.

In the Budget Grant column on the Dr. side all cheques drawn against letters of credit would be entered, as well as *all advances recovered.* On the Cr. side would be entered all expenditure proper, including of course advances made.

With the present system, according to the Assistant Comptroller General (and I have no doubt that he is right), advances recovered have to be entered in the *Cash* column on the Dr. side. I should like to ask "Why?" In nine cases out of ten no "Cash" is received, and even if it were it would be a return of money originally drawn from the Treasury, and its being in red ink sufficiently shews that it is not *freshly* drawn from the Treasury.

Combined with the above arrangement there is another which in my opinion vitiates the present system of keeping a Departmental Cash Book. It is the rule that the Cash Balance must be entered exclusively in the "Cash" column. In my view of the case, this is wrong. I hold that any revenue unremitted to the Treasury should be shown as a balance in the Bank or

Treasury column for the simple reason that the money is *destined to be paid into the Treasury*, and this method of dealing with the Cash Balance says at once that of the Cash Balance (the sum of the two columns) so much is balance from money drawn from letters of credit, and so much is revenue unremitted to the Treasury.

The Assistant Comptroller General says that it can only exceptionally happen that the Cash column on the Cr. side will balance with the Bank or Treasury on the other, and *vice versâ*. I confess that I cannot see why not at present; or at all events I can see nothing *which cannot be so arranged* that the "Cash" should balance with the "Treasury" column, and I maintain that, if it can be so arranged, the increased clearness of the accounts would be a great gain.

There is one other point to which I would draw attention. This is the treatment of "refunds." It appears to me that refunds, at all events *those made* in the same year in which the payment in excess occurred, ought to be paid to or from the source which made or received the payment in excess. According to my view of the matter the heads V, b, and AIX a, if used at all, should only be used when (from the accounts of the year in which the error occurred being closed) it is impossible to rectify the mistake in a thoroughly logical manner.

If I am overcharged and money is refunded to me I hold that the logical way is to pay back the money to the source from which it was expended, *i.e.*, it should be shewn on the Dr. side in the "Treasury," or as I prefer to call it, the "Budget Grant" column; but in order to prevent its being taken as a new remittance from the Treasury, I would enter it in *red* ink in the same manner as an advance recovered."

This proposition is equivalent to treating refunds to the Department no longer as revenue, but purely as an advance recovered in cash, unless it may be thought desirable to retain the present system for the case of a refund *made after the accounts of the year when the excess payment occurred had been closed.*

Refunds are really not revenue at all, and I can see no advantage in treating them as such, when it is possible to rectify the error in a logical manner. The case is analogous to a recovery

in Cash from a contractor who has not done sufficient work to cover the advances received by him.

If, on the other hand, I overcharge some one else, I shew too much revenue received. On discovering the overcharge, I have to refund, and as the revenue received the overcharge, it is the *revenue that ought to pay back the refund*, and therefore refunds of revenue ought to be shown on the Cr. side in the "Bank or Treasury," or as I would call it the "Revenue" column. This, too, being a refund, I would enter in red ink, for it will not appear in the Register of Revenue submitted by the Treasury. I, in fact, keep back that amount of revenue now, because I paid in that amount in excess previously. Thus, my total revenue for the year paid into the Treasury will be correct, and it is only when this desirable object cannot be attained, because the accounts of the year have been closed, that the other course, *viz.*, that of making the refund from the Budget Grant should be adopted. It is, perhaps, questionable even then whether the first course would not still be preferable, for the amount of revenue and expenditure in a series of years at all events will then be correct, which will not be the case if the present heads V, b, and AIX a, are retained. On the whole then, I am in favour of abolishing those heads altogether.

I am, etc.,

PENGELLY.

Method of raising Seedlings in Bamboo Tubes.

TO THE EDITOR OF THE "INDIAN FORESTER."

DEAR SIR,—It may be interesting to some of your readers to describe a method of raising seedlings practised in Australia,* and which I think likely to be of very great use to us, first in raising *Eucalyptus*, which we always cultivate in pots or something of the kind, and secondly in raising deodar, and indeed a variety of other delicate species. In the case of deodar, provided the seed is fresh, the crop of young seedlings in the *seed bed lines* is always all that we would wish. It is when we

* Note described in Reux des Eaux et Forêts July 1877.

come to put the plants out into the forest that the result is so often a failure, evidently because the roots are injured or because the earth is not pressed down : so that insects, water, and frost have all an equal chance of doing damage. If then we could be quite secure of lifting the young deodar in safety, and putting them in the rows, we should (provided the treading down of the earth were attended to) have but little chance of failure.

I think, therefore, that this plan is worthy of very careful trial, both for deodar and *Eucalyptus.*

Ordinary hollow bamboos are taken, of about 1 inch to 1½ inch in diameter and cut up into pieces (exactly) 4 or 5 inches long each; *of course, open at both ends.*

Square beds are then prepared just 4 or 5 inches deep : in fact, so as to form a sort of trays in the ground; the bottom of the bed may be trampled down, and if there is gravel and stone, so much the better, as roots will not be tempted to penetrate it.

The little tubes are then set up side by side till the square is full, and looks like the top section of a honey-comb. A quantity of good earth is taken and sifted, or made into powder free from stones and sticks. This is sifted or shaken over the bed till all the little tubes are full to the top and the interstices between them; 3 or 4 seeds (not more) are now, by hand, planted into each tube. A little practice soon enables this to be done very quickly. The seed has only to be lightly covered, in the case of pine and other small seeds, by an additional sprinkling of earth.

Water can very easily be given, and may probably be required.

When the plant is grown to a few inches, the superfluous plants or weak ones* may be weeded out of the tubes, and the tubes are now ready to be put out in their *final* position in the forest. No risk is felt to the roots, as each plant is in its own little case. They are planted out in lines, and the earth well pressed down all round. The bamboo gradually decays and the *plant is established.*

* Supposing all the seeds put in to have germinated together.

In Australia this method was specially applied to the blue-gum and the "jârrah," but would, I believe, answer well for deodar; it is worth trying not once, but several times, so that complete experience may be gained as to precise length of tube, &c. It may be found, for instance, that there is a tendency for the root to pass the tube and attach itself to the bottom of the bed, before the plant above appears sufficiently large to be moved into the forest. It may then be found best to lengthen the tube; thus little details come to be arranged, and experience is perfected.

I am, &c.
B. H. BADEN-POWELL,
Conservator of Forests, Punjab.

The Waste of Wood.

HERR VON ETZEL, Imperial Forstmeister (head forester, or inspector of forests) at Colmar, has recently contributed an exhaustive article on the destruction of forests and the waste of wood to a German technical journal devoted to matters concerning forests and their denizens, of which the following *résumé* appeared in the *Builder*. The waste going on in the forests in all parts of the globe is so enormous that it becomes of the greatest importance to devise means for preventing its continuance, and for this reason the remarks of a practical man like the writer are of especial weight, being sure to lead to reflection and to ensure improvement.

The author says that fifty or sixty years ago the production of wood exceeded consumption, and most countries grew enough for their own immediate wants; but the nearer we come down to our own time, the greater becomes the consumption of wood, a natural consequence of the rapid growth of trade and industry. Central Europe, and especially Germany, possesses, as is generally known, at the present day, still a very good stock of excellent old wood; but it is equally well known that this store is not inexhaustible, and that we shall hardly be able to grow and to leave to our great-grandchildren such a stock of wood as we have received from our ancestors. Want of money

compels Governments to wait no longer in public forests until trees are technically fit for being felled; financial reasons generally guiding them in the management of forests, which policy in some German states has already assumed, or is assuming, the character of mere financing. Increase is checked by the stock trees being cut too soon, before the total growth has reached its maximum point. The so-called rational economy of forests demands it.

After thus criticising the principles which regulate the economy of forests in Germany, the author asks: What is the position of foreign countries with regard to their forests? Referring first to Austro-Hungary, he says that, until very recently, it seemed as if that country were going to put all its forests to the hammer. The former impenetrable forests of Hungary, and of the lowlands of the Danube, can tell a tale about that, and the greater part of the seemingly inexhaustible tracts of forests in Croatia and Sclavonia has been changed into a bare and desolate waste. The river Save still carries vast quantities of wood annually down to the Danube and the Black Sea, and from Trieste hundreds of ship-loads of excellent wood from the Julian Alps are exported, year after year, to other countries, especially to England.

In Russia, vast tracts of forests have still been preserved, notwithstanding that yearly recurring forest fires reduce thousands of acres of wood to ashes. The consumption of wood in the country itself is very considerable, however, not only on account of the climate, but because, for want of stone, nearly all buildings have to be erected in wood. When once the country has been crossed, opened up, and made accessible in all directions by railways, the time will not be far distant when not only will there be no excess of wood, but when an actual want will make itself felt.

In England, *i.e.*, in the islands of the mother-country of Great Britain, forests proper of any considerable extent do not exist, although in the numerous parks there are still preserved many splendid specimens of old oak trees. But what enormous masses of wood, the author exclaims, are used in the wharves and building-yards of this country especially! No less

than four hundred million cubic feet arrive yearly from its own possessions in America, India, Australia, and from Scandinavia.

Sweden, Norway, and Finland have undertaken to supply all the coasts of the Atlantic Ocean with the wood of coniferous trees. Norwegian firs are found in Rio de Janeiro, as well as in the islands of the Southern Ocean. Thus it happens that the north of Europe has within ten years doubled its export of wood, and continues to manage its forests regardless of the future. In a report of the Norwegian Administration of Forests to the Government and the Chambers, it is stated that "the present destruction of forests has reached the limits of the permissible, *probably even* exceeded it." In addition it must be borne in mind that the soil there produces of wood only about the fifth part of what grows in Southern Germany; local consumption being, besides, very considerable.

France has only a few provinces rich in wood, and the import of timber has within fifty years increased threefold as regards quantity, eightfold as regards value, and is eight times as great as her own production.

Spain, Italy, the Levant, Africa—*with the only exception*, perhaps, of Algeria, where the fire of the Arabs has yet spared a few forests—are as good as devoid of wood, and draw their wants for buildings, fleets, and railways from abroad.

But Australia, and especially America, it will be objected, possess inexhaustible supplies of wood. This is a mistake. In the former part of the globe, far in the interior, considerable forests are said to have been discovered recently, but the transport of wood to the coast, and from there to Europe, will for a long time yet meet with insuperable difficulties, and be confined, on account of the great distances, invariably to the most valuable material. The wealth of North America in forests, however, will be exhausted, before the expiration of another generation, to such a degree that attention will be directed rather to import than to export. Already now England gets comparatively little wood from Canada. It is used in the country itself. Chicago, the great centre of the wood trade, sends enormous quantities to the prairies devoid of forests, to Illinois,

and Indiana, and the St. Lawrence carries still larger masses to New York.

It will be seen, therefore, that everywhere on the globe more wood is used than is added by growth, and the time does not seem far distant when it will be absolutely impossible to supply the curved timber and planks for ship-building, and the millions of oak sleepers, which are rotting under the rails of our fabulously increasing railways in the tenth part of the time it takes to grow and ripen the wood of which they are made. It is therefore high time, the author considers, to think of measures for meeting the great danger which is undoubtedly threatening, and not leave solely to posterity to help itself as well as it may, *in the perhaps too striking conviction that later generations will* be wiser than the present one, and that means will be discovered of which we have at present no idea.

In the first place, it is our duty, says the author, to put a stop to the excessive destruction of forests. As regards Germany, there has been for a long time no destruction, properly speaking, going on in the Crown forests; but even the sale of public forests should be reduced to the minimum, and should be confined solely to smaller isolated plots with excellent soil, or situate in the neighbourhood of numerous villages with a poor population. It is not sufficient to employ the sums realized in such sales in paying off the public debt, as is done most conscientiously, for instance, in Prussia; all the money gained should be reserved for buying and replanting tracts bare of trees, a certain percentage also of the net profits realized from forests being added to it. Legislative steps should further be taken with respect to the care of forests belonging to corporations and public institutions, and private owners ought also to be subjected to some extent to control by the Government. At any rate, wanton extirpation of forests in mountains, on sea-coasts, and other endangered points, should not be permitted in the interest of the public. A good beginning was made in Prussia in this direction, by the law of July 3rd, 1875, respecting forests which are a protection to the country, and it is to be hoped that this will be sufficient. But Governments have also other duties in the matter. The author recommends that

they should lend assistance to corporations, or private individuals without means, willing to replant their lands, whether in the form of loans, subsidies, prizes or by donations of seed or seedlings, and the gratuitous services of trained foresters paid by the State. A law also on disappropriation of waste lands, formerly forests, and now dangerous to the neighbourhood, after the pattern, perhaps, of that in force of France, might be useful. But it seems of the greatest importance to keep to the fundamental principle, at least in the case of public forests, that they are, in the first place, existing only for their own sakes and that of the wood, and that the realization of the greatest financial gain is only a secondary consideration. The department of the forests ought, therefore, in no country to form part of the ministry of finance, and its technical chief should be able to act independently, though at the same time he should be responsible to it.

But the principal aim should be directed towards putting a stop to the excessive waste of wood. No serious result need be feared with regard to wood used for firing, the pockets of individuals suffering more in the case of waste than the general community. Besides, the application of wood surrogates becomes more general. Wood, however, used for building and manufacturing purposes of all descriptions must be husbanded. Savings in this respect can not only be very easily effected, but they are imperatively required. For instance, the use of timber in the construction of bridges or viaducts should no longer be permitted, and pile framing, which consumes forests of timber, should be restricted to the greatest possible extent. The use of iron in building is not so general by far as it might and ought to be. Constructions of wood should be erected only where its physical properties, bad conductivity of heat, relative lightness, elasticity, exclude its being replaced by any other material. But the sorest point is the enormously increasing demand for railway sleepers. Here it may be rightly asked: Where is this to end? On the whole globe, only a fraction grows of the oak wood embedded annually below our rails, to rot there, notwithstanding all preparations, in a few decennials. It is only too certain that the second, perhaps the third, generation

reckoned from us will have to face the impossibility of building railways with oak sleepers, even though they were paid for with their weight in gold. Sleepers of other kinds of wood, being less durable, will also be getting dearer and scarcer, and will at last no longer be obtainable. The many experiments made to replace wood sleepers by other materials seem to have yielded at present only negative results, at least as regards beds of stone. Sufficient data have not yet been collected as to how far iron in the form of cross or longitudinal sleepers is suited to replace wood. It is therefore very desirable, the author thinks, that such experiments should be diligently continued, and that we ought not to cease with them until the proper *substitute for wood has been found, or it may be too late.—The Timber Trades Journal.*

The Mode of Clearing Timber Tracts in Russia.

By GEORGE EASTERBROOK, *Yambourg, St. Petersburg.**

SOME months ago I promised a paper on the above subject; I have waited until the proper season arrived for a very important part of the work to commence in our own forests before fulfilling that promise, as I desired to refresh my memory a little on some minute particulars regarding the operation of "drawing" the dravak (*i.e.*, firewood), and the beams from the place where they have been cut to the railway siding or the saw-mill. This drawing cannot take place until the snow has fallen in sufficient quantities to admit of the easy transit of sledges over the intricate and tortuous paths through the forest. We have now snow about a foot deep, which is considered enough for a commencement. In surveying a piece of forest with a view to clearance, the first consideration of course is, will it pay for cutting down? Is the wood of such a size that it may be sent to the saw-mill? or must it be cut down for firewood alone? I need not point out that the amount of profit accruing to the proprietor depends very much upon the answer to these questions. The smallest size put through the saw-frame is seven inches in diameter. Now, although a beam of this thick-

* Read before the Edinburgh Association of Science and Arts, 4th December 1876.

ness at the small end will fetch only a mere trifle *as a beam*, it is worth much less as firewood, notwithstanding that the price of the latter has risen very considerably during the last two or three years. Then, again, it is a matter of great importance whether the trees are growing thinly or thickly. The "cutters" who hew the wood demand a higher price for their labour if they have to clear a thinly wooded part, as of course the fewer the trees, the farther they must carry the pieces of which their stacks of firewood are composed. Suppose, however, that a portion of a forest has been selected for clearance, the cutters are engaged, and the work commences. It is doubtless unnecessary for me to say that the "moujiks" are expert timber hewers; *their mode is as follows:—If a wind is blowing, they observe*, quite mechanically, from which direction it comes, then with the cross-cut saw, worked by two men, or oftener by a man and boy, *most probably* father and son (and in some cases by a man and his wife), they saw the tree three quarters through from the side which is receiving the force of the wind; then removing the saw, they hack the other side with successive blows from their axes until the tree falls. A glance at the fibre of the tree is sufficient to enable them to judge to what purpose it shall be devoted. Superior wood is again cross-cut twenty-one feet long for the saw-mill. Inferior wood is cut up into eight feet lengths for railway sleepers. The top of the tree—that is to say, that portion under seven inches in diameter—is cut up into seven feet lengths for firewood, and split down the middle to facilitate drying in the sun. The beam of twenty-one feet must be cleared of its bark two-thirds of its length, which facilitates its drying, as well as prevents the depredations of grubs, which would otherwise soon lodge themselves under the bark, and worm-eat the timber. After cleaning, one end of the beam is raised a little out of the horizontal and rested on the stump: the effect of this operation is that it enables the drawers to recognise its position after the snow has fallen, and concealed objects lying flat on the ground. The tops of the trees, *after being cut to their proper length*, are split, as I before mentioned, and then collected into "Sazhanes" fourteen feet long, seven feet high, and seven feet wide. In making up

these "Sazhanes" the cutters show much dexterity. In order to keep them compact it is necessary that they should be supported at the ends. The cutter generally selects a spot where a couple of young firs are growing, not wider than seven feet apart. At the distance of fourteen feet he drives into the ground two stakes, and then his "Sazhane" is ready for filling. As the props are not sufficiently strong to withstand the outward pressure of the firewood in bulk, he resorts to simple means to strengthen them; he intertwines the small wiry branches of his props among the heavy pieces of firewood, and so actually makes the whole self-supporting.

Nothing but the most unceasing vigilance on the part of the proprietor or of his foreman will secure him against loss from the wilful carelessness of the cutters, who, if left to themselves, habitually hew the tree about a yard above the ground, and so leave what is a very valuable part of a fir tree behind them.

The point on which I am now dwelling strikes an English eye very strongly at first. In England, and doubtless in Scotland too, trees are cut as near the ground as possible, even though they may be old and partially rotten. Here it is the exception to meet with a rotten tree. *For the most part, indeed,* trees are felled here before they attain maturity. In one part of our forests, noted for its immense birch trees, a large district was cruelly sacrificed in this manner, and it is paying us to go over the spot again.

In order that you may properly understand the means adopted for removing all this mass of wood to a point where it becomes marketable, it is necessary that I explain to you shortly a few matters relating to the social habits of the "moujiks." A Russian village consists on an average of about fifty houses. Every year they select what they call a "starosta," or elder. The functions of this "starosta" are, to collect the imperial taxes from the moujiks, he being personally responsible for the amount; to enforce order in his village, and to see that each member works sufficiently to keep his family from starving; but, above all, he must see that the imperial taxes are forthcoming. The communities approve of this singular functionary. In fact, the idea seems to work very well, for I do not hear of

such persons overstepping their duties, whilst I can testify that without such an authority in their midst even the best-intentioned among them would give themselves over to sloth.

In order, then, to secure his community from *even the excuse of want of labour*, the "starosta" takes the first opportunity of providing his villagers with remunerative employment; *knowing this*, large employers of labour send their foremen to engage whole villages, horses and sledges included. The first person to be seen is the "starosta," who ascertains the nature of the work and the price to be paid for it. He then summons his flock, and after an incredible amount of haggling—a perfect Babel of voices in this district where so many languages are spoken—most probably a contract is made, advance or binding money is paid, a receipt given for it, and then the foreman may depart home—perhaps fifty, one hundred, or one hundred and fifty *versts* (a verst is about three quarters of a mile)—and wait for the snow.

Having ourselves made all these arrangements, we are now looking for the arrival of our drawers, and perhaps before this reaches you they will be here, presenting as nearly as can be, at *this time of the year and under such circumstances, a perfect human hive* of industry. It is a most lively sight on a bright sunshiny day to see some hundreds of men, horses, and sledges moving quickly, and, with the exception of the loud voices of the men, silently to and fro, and this in an atmosphere of twenty, twenty-five, or thirty degrees below zero of Reaumur. The scene is of course *altogether un-English. The dress of the* men and the equipment of the horses and vehicles are truly Russian.

The material they are engaged to deliver here comes in very rapidly; for although the horses are small, and, from an English point of view, badly fed, yet they are so wiry and pliable that they can draw immense loads upon the easily gliding sledges.

We have some fifteen thousand beams to draw, irrespective of firewood, of which there is a tremendous quantity ready for the drawers. Nevertheless our head foreman (a Polish Jew) states that he will have it all drawn by the new year. The firewood

will be sent away to the camp at Krasuve Selo, and to St. Petersburg, at the rate of three trains of twenty-five waggons each per week. The beams will be placed in mounds, separated according to size, ready for the saw-mill.

We have not a large quantity of red deal, nor have I seen much in this district; and notwithstanding that it is valued above white in England, it is sold at the same price as white in the saw-mills here; but our white deals are equal in quality, I believe, to the St. Petersburg standards. The wood is beautifully white, free from knots, and quite sound. There is not much demand for half-inch planks, and we only cut a few; but for one, one and a half, two, and three, there is a large demand.

I must not close this meagre account without adverting for a moment to the mode adopted by other saw-mill proprietors who are differently situated from ourselves.

It is the case with many, in fact most persons, that their raw article is a long way from the mill. Railway transit is out of the question, and advantage is taken of rivers to bear down the beams to the saw-mills—the nearest saw-mill to ours is on the banks of the Luga, about twelve versts away. For several years past it has only worked on half-time for want of water. Other saw-mills on the Narova are likely to be in a similar position soon. One large proprietor, who possesses two mills at Narva worked by steam-power, has just dismantled one of them for want of beams. The fact is apparent, say my friends at Narva, that yearly the water of these two Russian rivers is decreasing in volume. It is a very serious matter, *at Narva especially*, as a population of some seven thousand or eight thousand is dependent upon the continual working of cotton woollen, and linen mills, which are driven by water. It is true the late saw-mill is being converted into a flour-mill, for the proprietor is a very enterprising man; but the busy town of Narva, and its thriving suburb Krahnholm, must speedily sink into insignificance if the waters of the Narova do not keep up in volume.

It is quite within the scope of my present paper to inquire into the reason of this yearly diminution in bulk of these

Russian rivers. It is attributed, and I think *very justly*, to the gradual disappearance of forests in districts where they have existed for countless ages. Both the rivers I have alluded to, but especially the Narova, have cut themselves beds much below the surface of the surrounding country, through stratum after stratum of flat shellaty stone; thus pointedly designating their venerable age.

Standing on the banks of this river, or on one of the bridges that span it, you look down on the surface of the water, where floats many a beam which, in its time, as a tree covered with foliage, had *undoubtedly* attracted the element that now bears it on its bosom; and so far is the water from your level, that these beams appear to be only walking-sticks gliding along.

To such an extent has the despoliation of Russian forests gone, that a law has been broached, having for its object their preservation.

A proprietor is only to be allowed to cut down a certain percentage of his wood yearly, and this on condition that he replants the part cleared. I have no doubt that it will pass the Senate, though how far it will be enforced remains to be seen.—*The Timber Trade Journal.*

The New Forest.

THE Duke of Somerset was last week, after a debate in which both the Duke of Richmond and Gordon and the Lord Chancellor took part, induced to withdraw his opposition to the New Forest Bill, and the measure was read a second time in the House of Lords on Tuesday. It seems now probable, therefore, that, in spite of much heart-burning and opposition on the part of the Office of Woods, a satisfactory measure will, at last, become law. To use the words of the Lord Chancellor, the bill is probably a "very fair compromise."

The relative rights of the Crown, and the commoners under the original constitution of the forest were estimated before the Select Committee of 1849 as about equal in value, the interest of the Crown being enhanced by the existence of the forestal rights above the ordinary case of the lord of a manor.

Of the 63,000 acres of which the Forest consists, and over which the commoners have rights, about one-half consists of land of a good, or tolerably good, character, while the remaining half is bare heath land of an inferior description, and totally unfitted for the profitable growth of timber and trees. The Forest for some six centuries after the time of its afforestation consisted of woods interspersed with open glades or lawns. The woods were oak and beech, and so sparsely grown as to be open to the light, affording pasturage for the deer and cattle, and mast and acorns for the pigs; so that during the six centuries commencing with the afforestation of the New Forest and the date of the first Plantation Act of 1698, the rights of the Crown and commoners as respects commonable rights adjusted themselves with little complaint on either side. It is from these Plantation Acts that all disputes between the Crown and the commoners have arisen. By the Act of 1698 the Crown was authorized to enclose within a period of twenty years 6,000 acres, and to plant them with timber for the use of the navy; so long as the lands were enclosed they were to be free from rights of common, and whenever the trees were past danger from browsing of deer or cattle the enclosures were to be thrown open, and Commissioners were appointed to set out the lands to be enclosed. So little was done to carry this Act into effect that in 1808, after a lapse of 110 years, an Act was passed to enable the Crown to complete the enclosures authorized by the Act of 1698. The commoners do not appear to have been assenting parties to either of these Acts; but, owing to the limited extent of the enclosures, the system of planting, and the tasteful selection of the sites, their rights were very little impaired. In 1851 the Deer Removal Act was passed. As its name imports, it directed the deer to be removed from the New Forest, and further extinguished the rights of the Crown to keep deer; and in consideration of this extinguishment of the right of the Crown, Her Majesty was empowered to enclose 10,000 acres, in addition to the 6,000 authorized under the Act of 1698; and this Act, after the example of the Act of 1698, provided that the Commissioners appointed to set out the enclosures should select "such

places as should be best adapted for the growth and produce of timber, and might be best spared from the commons and highways of the Forest." About the time of the passing of this Act an entirely new policy was inaugurated by the Commissioners of Woods and Forests: the injunction to select for planting such spaces in the Forest as might be best spared from the commons and highways of the Forest was disregarded; the most valuable lands were planted, and the planting was so conducted as to render the land valueless when thrown open, and large tracts of land where covered with firs alone. So extensive was the planting that the commoners alleged that the object of the Commissioners could not have been profit; but that it must have been their intention to occupy the ground with a view to depreciate the interests of the commoners in the event of disafforestation and severance. The commoners were threatened not only with an injury to, but with a total extinction of, their rights; for the Commissioners of Woods claimed that the power to plant was a rolling power—that is to say, they claimed to have a right to make fresh enclosures, from time to time, provided on each occasion of making a fresh enclosure they threw open an equal number of acres of the old enclosure; in other words, they claimed gradually to make the Forest a vast wood, provided not more than 16,000 acres were actually under enclosure at any one time. The enclosures thrown open were made utterly valueless to the commoners, and the old and ornamental timber was gradually being destroyed. The commoners now began to agitate in earnest, and in June 1871, a resolution was passed by the House of Commons that pending legislation no felling of ornamental timber and no fresh enclosures should be permitted in the New Forest. There were now two courses open to the Government—one to disafforest, the other to reconcile by some less violent remedy the conflicting interests of the Crown and the commoners. The second remedy has been adopted; and we may be sure that to alter the character of a place of which the main features have been preserved unchanged for eight hundred years, and which, from its historical associations and scenery is an object of national interest and national pride, would be repugnant to

popular sentiment, and would never meet with the approval of Parliament. The general effect of the bill is to define clearly the planting power of the Crown. It will be enabled to keep enclosed at any one time 16,000 acres, but it defines the area over which the power is to be exercised, limiting it to the space already dealt with under the Plantation Acts. It will be freed from the intervention of any Commission, and may plant any description of trees whatever. The general effect of these provisions is, that the Crown may plant as it likes a space of ground amounting in acreage to about 16,000, comprising the greater part of the most valuable land in the Forest.—*Pall Mall Budget.*

Jungle Fires.

THAT fires cause a great deal of harm to forests is an undisputed fact; but there are some like Mr. M. J. Slym who believe (see paras. 9 to 13 of his Memorandum on Jungle Fires, published in the last January number of the "Indian Forester") that they act favourably towards the growth of forest trees. They believe also that the fires alter the condition of the forest atmosphere by driving away the noxious air and thus promote the healthiness of forests. But mind what a number of seedlings and shoots must be either killed or injured by them annually, and what a quantity of dead wood consumed besides. I think until the advocates of these fires prove practically by citing some instances in which the unhealthiness of forests has not been changed for the good during dry days without firing them, it would be more reasonable to suppose that the change in the atmosphere is effected by the heat of the sun rather than by fires. Such appears to be really the case. During hot seasons, when only these fires occur, a great number of trees lose their leaves, in consequence of which the rays of the sun reach the surface soil, carrying off therefrom the injurious air which, up to this time, accumulates under cover of green leaves. It is unnecessary to remark that in those forests which are allowed to be burnt over annually reproduction would be impossible, and if reproduction does not take place, forest conservancy must cease as soon as the standing trees are cut down.

2. I shall feel obliged if any experienced Forest Officer would throw more light on this important subject through the columns of the "Indian Forester." What I wish to know is, whether the forest atmosphere is not changed for the better during hot seasons without firing the forests themselves? I am very particular regarding these fires, as I have got the charge of most unhealthy forests, which are annually burnt over, causing thereby a diminution of their stock. It is my ardent desire to improve, if possible, the climate of the above forests without impairing, in any way, their capabilities as timber-producing tracts. Any practical suggestions that may be offered for achieving both the objects will be accepted with thanks and a fair trial given to them.

N. A. U.

Myrica Sapida.

At page 495 of his *Forest Flora* Dr. Brandis queries whether *Myrica sapida* (Kaphal or Kœphal) is always moderate-sized. In the fields of Jakhdeo village, (now bought by the Forest Department) near Ranikhet, there are three or four of these trees which are large, at all events of their kind. I measured the trunk of one, which was growing partly on the top and partly on the side of a bank—the wall of a hill field. It is hard to say, whether it originally grew on the top and spread down the side, or on the side of the bank, and in process of time overlapped the top. It was 4 feet from the top of the bank to the first branches, and 6 feet or more from the bottom of the trunk on the side of the bank to the same point. The trunk was 7 feet in girth above the bank, and the tree was spreading with a round head. I did not measure the height, but speaking from memory, I should place it at not less than 25 and probably not more than 30 feet.

A. P.

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The Forests of New Zealand.

The following sketch of the Forests of New Zealand is derived from, or may be called a review of, Captain Campbell Walker's report on the Forests of New Zealand, presented to both Houses of the General Assembly of that State in 1877.

Written for the perusal of members acquainted with the local details of the islands, a knowledge of such points is taken for granted. The maps that accompany the report do not in any way satisfy the topographical requirements of the ordinary, especially of the foreign, reader, nor do they profess to. At the same time, after a good deal of reading and re-reading, we are able, with the aid of a good Atlas, to make out something, and we may therefore attempt to present an outline sketch of New Zealand Forests to our readers. We must apologise in advance for shortcomings and for possible mistakes.

First, it may be noted that New Zealand consists of two islands—one called North Island, the other South Island.

The North Island lies between 35° 40′ and 41° 40′ South latitude, and the South between 41° 30′ and 47° 20′.

In their relative position the North Island bears to the north-west and the South Island to the south-east.

The North Island is mountainous; it is difficult from the Atlas (Stiehler's) to trace all the different ranges. The elevations attained are altogether inferior to those of the South Island.

Thus the highest peaks in North Island are Mount Egmont (8,270 feet) near the extreme westerly point of the island near New Plymouth, and Ruapehu (9,195 feet) about the middle of the

island and nearly due east of Mount Egmont. Near Ruapehu is Tongariro (6,500 feet).

The mountains of South Island are more easily defined. We have a continuous chain called the Southern Alps, chiefly along the west coast, but spreading out into a mountainous mass towards the north, over the Marlborough and Nelson districts.

The mountains in the South Island attain much more commanding elevations than those in the North Island. Thus we have Mount Franklin (between Nelson and Marlborough) attaining 10,000 feet, while Mount Cook, near the middle of the Southern Alps, rises to 13,200 feet.

From meteorological records compared up to 1873, we learn that in the North Island the rainfall is greater on the west coast than on the east; *e.g.*, the annual rainfall of Taranákí on the west coast is 60 inches, while that of Napier on the east coast is only 30 inches.

This is still more marked on the South Island, where, on the west coast, Hokitika has 120 inches, while Dunedin, on the east coast, has 30 inches, and Christ Church 40 inches.

On the west coast the glaciers come down from the Alps within about 700 feet above the sea level.

The geological formation of the upper portion of North Island consists of trachytic and basalt rock overlying palæozoic slates, often broken and displaced, with overlying patches of tertiary rock, clays, sandstones, and sometimes limestone.

Lower down from the region of the Bay of Plenty commence the ranges, which are in fact a continuation of the Alps of the South Island. The highest peaks of the range are 6,000 feet, for the great peaks of Ruapehu and Egmont are volcanic.

The South Island is distinguished by the range of Southern Alps, having a similar formation to that already described. The east side of the island, for some distance south, is covered with tertiary gravels, silts, shingle, clays and marls as far as the Clutha river.

On the west side the Alps slope off in masses of schistose rock as far south as Jackson's Bay, at which place the schists cross

the island in a broad band towards the Clutha already alluded to. Below this point the southern section of the island is occupied by palæozoic slates, and below these by slates, quartzites and conglomerates. We shall notice the special meteorological features hereafter. It may here be noticed that it is extremely difficult to follow Captain Campbell Walker's descriptions, because he constantly alludes to ranges, rivers and other local features, the names of which he does not insert on the map.

The second part of the Report contains matter of the greatest interest. The Reporter's endeavour has been to divide the two islands each into districts, characterized by some dominant species.

This is no easy task, for all the Forest in New Zealand is very mixed, "except on the elevated parts of the South Island it is comparatively rare to find extensive areas of forest composed exclusively of a single species." It is accordingly difficult to select typical trees.

The North Island is divided into three portions—the Northern (Kauri district), the Central and South-eastern (Totara), and the South-western or Red Pine district.

The South Island has the forest chiefly along the Alps; the lower portion being Red Pine (*Rimu*), and the upper various beeches. The east coast has only Red Pine forest in occasional valleys.

Thus for North Island; draw a line from the mouth of Waikato river on the west to Tauranga Harbour on the east, and all to the north of that is the special region of *Dammara australis*, Lam. (Kauri Pine), which does not seem to appear anywhere *south of this line at all.*

The Tawá or (*Nesodaphne Tawa*, Hook f.) prevails especially in narrow gullies.

Swampy districts are occupied by *Podocarpus dacrydioides*, A. Rich., called the 'White Pine.'

Large blocks are also covered by the "Tea-tree" (*Leptospermum ericoides*, A. Rich.)

There are also species of olive which grow to a large size, and with them Sandalwood (*Santalum Cunninghamii*, Hook f.)

The *Metrosideros*, with its splendid crimson flowers in full bloom at Christmas, is a special feature of this district.

A large species of *Vitex* also forms pure forest in some of the valleys. The peculiar tangled undergrowth of Alseuosmia (*Caprifoliaceæ*) with *Rubus* and *Lygodium* and other species are said to protect the forests from fire, as long as the undergrowth is uninjured.

The beech is said to occur in this district, but the map shows it only once in the north, and again below Mount Egmont and the Tararia range.

In this district also occur *Knightia,* a tree honey-suckle, and a *Fuchsia,* not the small hybrid flowering plant of our green houses, but (*F. excorticata,* Linn. f.) a tree with a trunk often 2 feet in diameter and with durable timber.

The rest of the island, with the exception of the south-west portion, is the region of the Totara (*Podocarpus totara,* A. Cunn.) ; beech forest also occurs in the hills.

Tawa (*Nesodaphne*) and White Pine (*Podocarpus dacrydioides*) are common trees.

The south-west portion, or Red Pine district, may be roughly defined by starting a line from the mouth of the Mokau river bending round southward below Mount Ruapehu, and down to the upper end of Palliser Bay towards Wellington.

The Red Pine, or *Dacrydium cupressinum,* is the characteristic tree; but Totara still appears, and beeches on the heights. Black and White Pine also occupy considerable tracts, (*Podocarpus spicata et dacrydioides.*)

The giant honey-suckle (rewa-rewa) *Knightia,* here attains its greatest dimensions.

The SOUTH ISLAND is more easily described. Imagine a double belt drawn round the north, west and south sides of the island, the east side only representing the double belt by occasional patches chiefly extending up the river valleys.

The belt along the low-lands is that of the Red Pine, already noticed in North Island; the belt on the heights (above 1,000 feet) is that of the beeches.

The forest growth on the west coast, which (as already shown) has the greatest rainfall, is luxuriant. Though the Red Pine is characteristic, it does not attain the dimensions that it does in North Island. Here also (about Westland and Nelson) is the

Dacrydium Westlandicum, n. s., iron wood (*Metrosideros lucida*, Menzies), cedar (*Libocedrus Bidwillii*, Hook. f.) and *Weinmannia*.

The beech district is on the hill slopes.

The chief beeches are locally cited 'Birch,' because some have a white bark like the home birch.

The species are—

Fagus cliffortioides, Hook. f.

Fagus fusca, Hook. f., the tooth-leaved beech.

F. Menziesii, Hook. f., the round-leaved beech.

F. Solandri, Hook. f., the entire-leaved beech.

Large trees do not occur over 2,500 feet on the mountain slopes, and the tree itself does not ascend at all above 3,500 to 4,000 feet.

The following Table will exhibit the chief meteorological peculiarities of the different Forest Districts :—

NORTH ISLAND.

1.—Kauri District (Northern.)

Locality.	Average mean temperature.			Rainfall.	Mean degree of moisture.	Prevailing wind.
	Summer.	Winter.	Mean for year.			
General ...	66·7°	52·7°	59·7°	...	76°	......
Mongonui ...	...	...	...	55 ins.	...	S. W.-N. W. E.
Auckland ...	...	...	...	43 ins.	...	S. W.-N. W.-W.

There is only 16° of extreme difference between heat and cold.

2.—Central or Totara District.

General ...	66 2°	49·1°	57·5°	36 ins.	...	N. E.
West Coast ...	...	...	...	50 ins.	...	......

The climate is drier than in the north. Temperature difference 19°.

3.—Western or Red Pine District.

General ...	...	...	...	...	...	......
New Plymouth ...	64·5°	50·1°	57·5°	60 ins.	...	S. W.-S. E.-N. E.
Wellington ...	62·2°	48·7°	55·5°	57·86 ins.	...	N. W.-S. W.

Inland portions of this district have heavier rainfall and lower temperature than Wellington. Temperature difference 14·7°.

SOUTH ISLAND.

(The great general difference in moisture between the west coast and the south and east coast has been generally alluded to).

1.—South Lowland or Red Pine District.

Locality.	Average Temperature.			Rainfall.	Prevailing wind.
	Summer.	Winter.	General		
Hokitika (W.) ...	...	...	52·3°	115·418 ins.	E. N. E.
Oamaru (E.) ...	...	...	...	under 20 ins.	......
Nelson (N.) ...	...	...	54·8°	68·068 ins.	......
Christ Church (E.)	...	...	52·8°	25·821 ins.	S. W.-N. E.
Dunedin (E.) (lower end) ...	...	...	50·7°	31·346 ins.	N. E.-S. W.
Southland ...	...	...	50·3°	41·090 ins.	N. E.-S. W.
Cape Campbell (E.)	...	...	...	24·830 ins. N.B.—(Means of 5 years.)	......

The consequence of the aridity is, that the winter temperature of the east coast is from 2 to 3° lower than that of the west.

2.—Beech District.

In the upland district meteorological data are wanting. Observations have been taken at two points only—Bealey (2,104 ft.) on the eastern side of the Alps, and Queenstown (1,070 ft.) ; on the margin of a lake are :—

Bealey ...	54·86°	37·40°	45·76°	97 738 ins.	W. N. W.
Queenstown ...	51·7°	59·2°* (*sic*)	51·0°	30,782 ins.	N. W.

* Query 50·2 ?

We must now give a brief description of some of the species we have enumerated. Captain Campbell Walker divides the whole of the observed species into three classes, *viz.*, trees suitable for

building and constructive purposes, those suitable for similar purposes, but not possessing great durability, and those of small dimensions useful for industrial purposes.

1st Class.—Foremost comes the Kauri Pine (*Dammara Australis*, Lam.) ; the finest tree in the island; attains 120 to 160 feet in height, and from 5 to 12 feet in diameter. Timber exposed for 30 years has been observed to show no signs of decay. Suitable for ship-masts, mine props and buildings, and for sleepers: in the sea the *teredo* attacks it. It is largely exported. For the 7 years ending 31st December 1873, the value was £144,068 against £19,739 of all other kinds.

The report describes this pine tree as showing "huge cinereous columns," rising 60 or 80 feet clear of branches. At the base of each shaft is a mound of *humus*, chiefly arising from the decomposition of its shed bark and leaves. The branches are massive and spreading, clothed with deep green foliage. A deformed tree is rare; undergrowth never dense.

The Totara (*Podocarpus totara*, A. Cunn.) grows either on rich alluvial land or dry hill sides, and is found throughout the colony. The *Podocarpus* is a genus of pines, of which South Indian foresters and those who have visited Calcutta will have knowledge. The species in the Eden Gardens (*P. neriifolia*, Don.) looks hardly like a conifer, the needles being broadened into narrow leaves, and the fruit very peculiar; it is succulent and round, borne on a thick fleshy stalk (whence the name of the genus). It belongs to the section *Taxaceæ*, its fruits being something like the yew berry.

The genus *Dacrydium* spoken of in this Paper is nearly allied to *Podocarpus*. The New Zealand Totara is not so big as Kauri, but sometimes attains 10 feet in diameter, and is from 40 to 70 and even 100 feet in height. Its use in Wellington occupies the place of Kauri in Auckland. The trunk tapers rapidly; the leaves are coriaceous; ¾ to 1½ feet long, lanceolate, and of a peculiar *brown* hue. Two other species of *Podocarpus*, both confusedly called Black Pine (matai and mira). *P. spicata* and *P. ferruginia*, may be mentioned under this class of timber.

The Cedar Pahantea (*Libocedrus Bidwillii*, Hook f.) gives a dark red, very durable, but rather brittle timber; grows above

1,000 feet on the central ranges of North Island. The tree is smaller than the preceding.

I have not before alluded to the celery-topped pine, (*Phyllocladis trichomanoides*, Don.) This is like Memel deal in everything but size. It grows in hilly districts of North Island only. Three species of *Dacrydium* also occur in this class of coniferous timbers.

The Tooth-leaved Beech (*Fagus fusca*, Hook. f.) called by settlers "black birch," confusedly with many other species, is the largest of the New Zealand beeches. Often from 60 to 90 feet in length; it grows from 3 to 8 feet in diameter. The leaf is sharply serrated. The timber is red and durable.

The Round-leaved Beech (*Fagus Menziesii*, Hook) comes next in size, and appears about equal in quality, though situation and soil affect the quality of timber produced.

Captain Campbell Walker includes, under the name of "New Zealand teak," the Pariri or (*Vitex litoralis*, A. Cunn.)

The tree is in durability probably superior to all others in New Zealand. It rises to 40 or 60 feet, and has a trunk from 3 to 5 feet in diameter. It occurs only in the northern half of North Island.

In this class are also included the Tea Tree (*Leptospermum ericoides*, A. Rich.) (*Leguminosæ*), which is especially valuable for works requiring immersion in sea-water. The tree does not exceed 1 to 2 feet in diameter; the foliage is light and graceful.

We can only mention two more species—the Iron Tree (*Metrosideros*) which splits easily, and the Olive (*Olea apetala*, Vahl.), which has large glossy foliage, grows from 50 to 70 feet high, with a trunk from 2 to 4 feet in diameter. It is sufficiently smooth to be useful for wood engraving.

It is to be remarked that no representative of the oak occurs, the *Cupuliferæ* being only represented by beeches.

In the SECOND CLASS (trees of similar uses, but of less durability,) come the Red Pine, Rimu (*Dacrydium cupressinum*, Soland.) The tree grows from 40 to 80 feet in height, and from 3 to 5 feet in diameter. The bark of mature trees is in large scales like the Scotch fir. The leaves are bright green, very short, subulate, and more or less imbricated. The young branches

are pendent, not simply drooping, but hanging in lines parallel to the stem. The wood has the great defect of being liable to decay when exposed to wet.

The other two beeches also come into this class.

Two species of *Elæocarpus* are enumerated, and the *Nesodaphne Tawa* of North Island, the latter has an elegant willow-like foliage and a handsome fruit a little larger than a damascene.

The rewa-rewa, or honey-suckle (*Knightia excelsa,* Br.) is a perishable timber out of doors. It has a fastigiate habit, rigid leaves, and red flowers. The wood is beautifully variegated, and might be largely used by cabinet makers. It is much destroyed at present in clearing land.

Similarly *Dysoxylum spectabile,* Hook F., might be prized by cabinet makers for its compact red timber.

The THIRD CLASS includes a greater variety than the others.

There are found the *Fuchsia,* a *Quintinia,* two myrtles, a pepper tree, or *Drimys,* useful for inlaying, three *Pittospora,* suitable for turnery work, several *Panax* (lancewood), a *Dracophyllum* (grass tree) both prettily marked woods, two species of *Myrsine,* two olives, and the sandalwood, which is hard and smooth, but is not stated to be scented.

An Epicarpurus (*E. microphyllus,* Raoul.) has an abundant milky juice; whether this has any of the properties of caoutchouc is not stated.

A Mangrove (*Avicennia officinalis*) occupies the mud flats to the north of Tauranga harbour, and is said to contain an unusual percentage of potash.

Besides timber, Kauri gum obtained in great masses of resin found buried (as the African Copal) is largely exported. The exports in ten years, from 1867 to 1876, amounted to £1,171,949 in value. Its price may be given at from £33 to £39 per ton.

The barks of beeches, mangrove and other species, especially the Towai or *Epicarpurus,* which is superior to oak bark, are exported, but in small quantity.

A peculiar Fungus (*Hirneola polytricha,* Mont.) is exported to China, where it is boiled and eaten with bean curd and vermicelli. In 1876, 2,633 cwts. were exported, valued at £6,224.

Tree Ferns are also exported to value of £600 per annum.

The report now goes on to speak of PLANTATIONS. In this richly-wooded country clearings have been so rapid that already it has been necessary to restore some of the denuded estates.

It appears to be chiefly, if not entirely, private enterprise. Many towns have public gardens, and European species of Conifers and Norfolk Island Pines (*Araucarias*) have been successfully cultivated. The blue gum and other *Eucalypti* have succeeded in various places.

An Act passed in 1875, called "The Tree-planting Encouragement Act," seems to have resulted chiefly in local and ornamental grove planting;—similar to that done by our District Officers in Northern India: the total area planted under it is 382 acres.

While it seems highly desirable that various species should be introduced, it is evident that the great work in New Zealand should be to preserve and encourage valuable indigenous kinds. Where there are denuded wastes, as at Otago, the Canterbury Plain, &c., the cultivation of the *Eucalyptus* cannot be too zealously pursued; but it seems pure waste to introduce such comparatively worthless species as *Pinus* (*Abies*) *Smithiana* and *Webbiana* into a country which naturally produces *Dammara, Dacrydium, Podocarpus* and other valuable conifers.

A chapter of the report is devoted to the subject of Timber Trade. The returns given are confessedly imperfect. It would appear that the imports exceed the exports, the former in 1875 being valued at £179,420, and the latter £178,714.

The import is chiefly from Australia. Regarding the exploitation of the forests the following extract may be given:—

"I consider that the felling and removal of timber, known by the French as *exploitation*, is carried on in New Zealand in a most expeditious and workmanlike manner; but, from the large supply and comparatively low rates generally ruling, especially for small stuff, without much, or indeed any, consideration as to waste of material, and still less of care in its removal not to damage the young crop of trees left standing.

"Felling is usually performed with the axe; indeed it is only on the West Coast (near Hokitika) that I found the saw in general use for this purpose, one side of the tree being first scarped with

the axe. The saw recommends itself wherever material is scarce, as its use certainly effects a saving of several cubic feet in a fair-sized tree, and wherever it is desired to fell trees carefully and in a certain direction so as to interfere as little as possible with the standing crop. It could not, however, be brought into general use with the Kauri, from the enormous size of their trunks, and I am not sure that it is economical as regards labour, although the bushmen at Hokitika consider it is so. When the tree is felled, one or more logs of convenient lengths are cut out of the trunk by cross-cutting, and the rest, including top, lop and branches, left lying in the forest. It is very striking what fine pieces, which would be of great value in other countries, are thus left to rot or burn: this is especially the case in the Kauri forests, where none but the best portions of the finest trees have been, as a rule, made use of, and where the bushman looks with contempt on anything under 3 feet diameter, which he terms a 'ricker.'

"The logs are next moved to the side of the timber slip, where such is used, and rolled down it to the nearest siding on the tramway, or dragged, generally by bullocks, direct to the tram. I have not seen any regular rolling roads, except in the Kauri forests, where on the other hand the work of getting the logs to the tram is done by manual labour, whereas in others bullock power is used The Auckland bushman makes use of a powerful auxiliary in the shape of the screw-jack, and it is marvellous the amount of work two men trained to its use will get through, and the enormous logs which they will move about as required by its aid.

"In other parts of the colony, where the logs are smaller and lighter, the jack is not much used, its place being taken by what are known as cant-hooks of various constructions.

"The universal use of the tramway forms a marked feature in the treatment of New Zealand forests. I have seen them of all descriptions, and no saw-miller ever dreams of working a forest without one. They are, as a rule, constructed by bushmen on contract, the price per chain varying greatly, according to locality, nature of the country in which the forest is situated, and size of timber to be taken out. In the Pelorus, near Havelock, the forest tramway assumes the shape of a regular light railway, with iron rails and locomotives specially constructed and solely used for the transport of timber; but, as a rule, the rails or longitudinal sleepers are of wood; their construction is identical with those

met with in Switzerland (described in the supplement to 'Reports on Forest Management'), and the haulage is by horses. I have seen no such system *generally* applied in any of the forests I have visited out of New Zealand, but it may possibly be common in America.

"Floating is common for the transport of timber in the Auckland district, where dams are constructed on the smaller rivers or streams to store up the water till required. One of those which I saw at Mangawhau costs as much as £1,000.

"The use of dams on the subsidiary streamlets to augment the supply of water as required would probably be found an advantage, and still more the preparation, by means of sleepering, and construction of locks on the stream down which the logs are floated, as is universal in the Black Forest and other parts of the Continent of Europe, where, however, the supply of timber, being under systematic management, is permanent and regular—not, as in the Kauri forests, merely temporary.

"I have not seen floating in any other parts of New Zealand, though it is resorted to in Otago, and doubtless elsewhere, the main difficulty being, as in India, that many of the timbers will not float unaided in a green state, and there is at present no demand for the lighter descriptions which might serve as floats or rafts. Taken as a whole, there is nothing to find fault with, and much to admire and copy elsewhere, in the felling and transport of timber in and from the forests to the mill or market, except the waste, and damage caused to what is left—evils which will cure themselves when the produce is more scarce, and found only in more inaccessible places, requiring a greater outlay of capital to work a forest, and pieces and descriptions now discarded as worthless acquire a marketable value. Systematic management, and the leasing of only such portions of the forest as are actually required to supply the demand, or which it is desirable to clear for the extension of settlement, will also tend to this result. At present, any one working a tract of forest knows he can readily get another, and consequently finds or considers it preferable only to take the cream, and leave one block for another. This system would not so much matter were the worked portion left in a state to recover by the process of natural reproduction; but unfortunately it is not so. The saplings have already been rudely damaged; the covering or compactness of the forest has been

abruptly broken, and a flood of light and air suddenly admitted. Decay of the half-mature trees sets in, and fire generally follows, which, fed by the *débris* and want of healthy vitality in the growing trees, completes the havoc, and destroys the forest for ever."

At the end of 1876, 125 saw mills were in operation, turning out 103,039,037 superficial feet; but as the return is incomplete, both the number of mills and the outturn must be considerably larger.

No returns are available for the quantities of wood used for fencing; as this method of protection is largely resorted to in New Zealand, the quantity of wood used must be enormous.

Nor is firewood taken into account. This must be very large, as the annual demand for Taranaki is 93,750 tons, for Otago 480,000 tons, and Auckland town 25,000 tons.

After a series of notes on the existing regulations for working forests in New Zealand, and which shows chiefly a system of unchecked licenses to cut over large areas for a small payment, Captain Campbell Walker concludes his report by some excellent observations on the climatic value of the forests, and by a series of recommendations for the formation of a regular State Forest Service and for the demarcation of large forest estates under the control of Government. All this part of the Report is most admirable, and deserves the very earnest attention of the New Zealand authorities.

It is unnecessary to repeat the arguments by which it is established that the State alone, from its longevity and from the absence of temptation to gain quick returns by reaping a harvest within a few years, is fitted to manage high forest, which must depend on the method of natural regeneration for its maintenance.

It is of no use having licenses, unless distinct estates are formed carefully demarcated, subject to proper legal protection, and managed pursuant to a regular system, which has for its object the realization in the best way, of the largest and most valuable return, which must never exceed the legitimate interest on the growing capital, or the normal annual yield obtained from a forest kept in the highest state of productiveness.

We trust, in conclusion, to hear ere long that Captain Walker's suggestions have been carried out, that a Government Forest Service has been organized, and demarcation set about in earnest.

B. H. B.-P.

The Jeypore Forests.

From Lieutenant-Colonel R. H. BEDDOME, *Conservator of Forests, to the* SECRETARY TO GOVERNMENT, *Revenue Department, dated Ootacamund, 29th March* 1877, *No.* 1790.

G.O. No. 808, dated 29th June 1874.
G.O. No. 600, dated 16th April 1875.

WITH reference to the Government Orders as per margin, I have the honor to inform you that I have completed a tour through the Jeypore plateau and the forests of the Malcangiri Taluq.

2. Arriving at Vizagapatam at the end of December, I immediately daked out to Salur, and ascending the Potingee Ghaut I spent two days in exploring the forests on the eastern slopes of the plateau; and afterwards meeting Captain Blaxland near Koraput, we traversed the plateau *viâ* Bijapore, Nundapur, Sogaru, Baliguda, Jangore, and through the naked country, and afterwards descended to the Malcangiri Taluq at Buckonguda; thence I went north to examine the Sal forests, and we afterwards marched down to Kondakamberu to examine the forests in the valley of the Silaru; thence crossed over to Malcangiri itself, and I eventually left the district at Moat on the 9th of February.

3. *The Woods or Forests of the Plateau.*—The higher plateau in the Zemindari of Jeypore all lies to the south of Jeypore itself, and is about 3,000 feet elevation, and is dotted all over with small hills, which rise to a little over 4,000 feet elevation; in the Zemindari of "Hill Madgole" these latter often rise to 5,000, and in two cases (Yendrika and Arma) to about 5,300 and 5,500 feet. This plateau is wonderfully well-watered by numerous streams, which all have their rise in the woods which more or less clothe all the small rising hills alluded to. These latter were all, at very recent date, covered with fine forests,

but this is fast disappearing, owing to the ruinous system of hill cultivation (Kumari).* Numerous hills have already been turned into bare rocky waste, or are only clothed with a few date bushes or the poorest description of stunted growth; and if the present system of cultivation is allowed to go on unrestricted, the entire disappearance of all woodlands is only a question of time.

* Here called Podu.

4. Over the whole portion of the plateau visited I did not find a single patch of virgin forest, except here and there very small plots (scarcely over half an acre) where reservation had occurred on account of some sacred stone. Every acre has, at some time or other, been felled and burnt for hill cultivation, and is at the best only second growth; but most tracts have seen probably many rotations of this system, and, consequently, the forests are to be seen at every stage of deterioration.

5. About the crests and upper slopes of the eastern and western ghauts of the plateau, *i.e.*, about Potingee on the eastern slopes, and all above the Malcangiri Taluq on the west side, the hilly tracts are denser and less accessible, and the forests more abundant and of older growth generally than on any of the hills about the centre of the plateau; the oldest growth any where observed by me was about forty or fifty years, and in almost all cases where I found forest above thirty years of age I was informed that it was marked for early destruction.

6. The woods are neither wholly evergreen nor wholly deciduous, but a mixture of both, and similar to what is met with in some parts of Coorg and Wynaad. Vengay (*Pterocarpus marsupium*), Matti (*Terminalia*), Irul (*Xylia dolabriformis*), Poova (*Schleichera trijuga*), Chinangi (*Lagerstrœmia parviflora*), Chiriman (*Anogeissus latifolia*), and many other deciduous timber trees are mixed with evergreen trees, chiefly *Lauraceæ* (Machilus, Tetranthera, and Litsœa), *Michelia champaca*, *Artocarpus lakoocha*, rattans, tree ferns, and acanthaceous bushes; felled and burnt, they do not suffer at once in the same way as the heavy evergreen forests of the western side of the presidency; the same growth more or less appears, not a thorny wilderness of quite different plants. The burning is at first at least very superficial, and the stumps, or a greater portion of them, at

once begin to grow again; and when the cultivation is abandoned, which it generally is after two years, the forest soon begins to recover itself. The evergreen trees suffer more than the others, and these are more or less absent at first, and for some years rank grass and much thorn and coarse under growth hold sway, and fires periodically sweep through, and it is not till the growth arrives at an age of some twenty years or more that there is any chance of much humus being added to the surface soil, and then fires are soon excluded, seedlings have a chance, and shortly afterwards rattans and tree ferns appear, the evergreen trees increase in number, and the undergrowth quite changes its character and species of acanthaceous shrubs (*Strobilanthes*) appear as in our moist western sholas.

7. This is a sketch of what occurs after the first felling of a virgin forest, or when the forest has been allowed forty or fifty years to recover after a "Kumari." A virgin forest at this elevation is a fine sight; it is moist and shady, and tolerably open for walking through or for sport. Rattans and tree ferns, orchids, and moss abound. The trees are large, and there is much valuable timber. When a tract is allowed forty or fifty years to recover, it appears to return almost to its pristine vigor and form, and many seedling trees in time make way; and unless the base of the older trees be observed, a forester even might be deceived, and fancy that he was in a virgin forest. It is, however, only in a few tracts, chiefly on the eastern and western ghauts of the plateau where the hills form a chaos, that the forests are allowed a rest of any long duration. About the more accessible and less densely-forested portions they are felled over every eight, ten, or fifteen years, and never have a chance of recovering. They have a wretched, stunted appearance, are very dry and more or less impenetrable from a tangled rank undergrowth, and there are no seedlings; nothing, in fact, but the coppice growth generally of only the quicker growing, but poorer sorts of timber. To the uninitiated these tracts are generally looked upon as having been *ab initio* of the same poor, stunted growth, but it is only the result of rotations of felling and burning and consequent poverty of the soil.

8. The south-west monsoon is very heavy on these hills, and

when a tract of forest on the slopes of the hills, which rise all over the plateau, is felled and under cultivation, and before the forest again begins to grow, the denudation of soil is very great. The traces of this are everywhere apparent, and I had ocular demonstration of it on several occasions, as there was some very heavy rain whilst I was up. Besides this denudation, when these tracts are felled over at such short periods, there is no virtue added to the soil by the decaying vegetation, and tree-growth cannot flourish: each rotation is poorer and poorer till at last it disappears altogether.

9. I have nowhere in India seen this Kumari cultivation so systematically carried out. Directly all the forest within a certain radius has been felled and cultivated, the village is deserted and the cultivators move off to other tracts to carry on the same ruinous system. Numerous deserted villages are to be seen all over the plateau; the site is almost always marked by a good many grand old Tamarind, Mango, and Chumpa trees, generally of about a hundred years' growth, and in most cases by a few tumbled-down huts; these sites are probably always returned to periodically.

10. I had no means of ascertaining how many years this destructive practice has been regularly carried on; but it is probably less than a century in many of the wilder parts, and much more than that, perhaps several centuries, in the more frequented portions of the plateau, where the forests are fast disappearing, or have already disappeared. When examining several of the finer tracts of forests, which I estimated at about forty to fifty years' growth, the natives assured me that they had only been felled once, and that by their grandfathers. I would not attach much importance to such evidence, but it tallied with what I considered most probable.

11. There is no necessity for this indiscriminate destruction over the whole length and breadth of the country: the plateau is splendidly watered by many streams, and there is much cultivation in the vicinity of all these, and certainly room for much more. In these localities it is almost entirely rice that is cultivated. The hill cultivation which is chiefly castor oil, ragi, bajra, tour, &c., must, of course, be allowed to a certain extent;

but considering how very sparse the population is, it would cause little or no inconvenience to the people and much ultimate benefit, if one-fourth or one-fifth of the forest tracts were to be reserved against this ruinous system of felling and burning, and only be open for the thinning out of timber annually equal to the reproduction.

12. If this is not done, there can be no doubt of the ultimate results. Two or three centuries hence, there will be no wood on these mountains. The wooded ravines all over the plateau, in which all the numerous streams which water the plateau and eventually form the rivers Silaru and Saveri (most important tributaries to the Godavery), have their rise, will cease to exist, and can never be afforested. Though this may not affect the rainfall to any great extent, the water will run off in torrents during the rainy season, and the streams, or at least many of them, will cease to be perennial, the climate will be seriously affected, and the result will be ruin to the country. It may be said that this is a long time to look forward to, but the changes have been, and are going on, slowly perhaps, but not the less surely, and though perhaps not often very apparent to any one generation, much less to the Revenue officials who are only perhaps located in the district for a few years. If we could have data over a period of a hundred years or much less, we should see most marked changes for the worse; and I observe that Mr. Turner reports the failure of streams and the entire deforesting of tracts within his experience (only some five or six years).

Vide paragraphs 7 and 8 of his letter recorded in G. O. of 29th June 1874.

13. I did not visit the more northern portions of the plateau whence the streams feed the Indravatty river; but Captain Blaxland informed me that exactly the same indiscriminate felling has been and is going on there; the elevation in these more northern portions is only about 2,000 feet, and the forests much poorer.

14. Sal does not grow on the 3,000 feet plateau, except a few isolated patches of stunted growth, which at a distance have much the appearance of hop-gardens, and Teak is not found, but there are many other valuable timbers. I have however, only considered the value of these forests in a climatic

point of view, as there is no market whatever for the timber; it would never pay to take it down, but at some future date a market will probably arise, and a certain reservation is necessary on this score.

15. Mr. Turner proposes to parcel the country into mutahs, and extend the prohibition on hill cultivation gradually. Something ought to be done, and that speedily. I would reserve against all Kumari cultivation one-fourth or one-fifth of the forest within the limits of each village or of certain circles or defined limits. Three forest Darogahs might be appointed for the plateau,—one for the northern portion, to be stationed at Jeypore or somewhere further north, one for the south, to be stationed at or near Nundapore, and one for "Hill Madgole:" (but the latter is a Zemindari of itself, and does not belong to Jeypore). These men should all be under the orders of the Special Assistant Collector, and should work with him and the native Revenue officials of the Raja in marking off the tracts to be reserved; and after pillars or boundary marks are once erected, they should be held responsible against any encroachments of "Kumari." I would not propose a forest officer at present, but it might be found necessary to appoint one temporarily to get matters into trim, or to appoint one permanently at no very distant date; but I think that the Agent's and Assistant Agent's advice ought to be taken on this point. The three Darogahs need not put the Raja to a greater expense than Rs. 150 a-month with perhaps an addition of Rs. 15 for three peons; and a small tax on timber used locally and on the export of hill produce, &c., would probably cover this.

16. Mr. Turner states that the Raja will be glad to meet the wishes of Government in the matter. Captain Blaxland informs me that, though the Raja would probably do anything that he was ordered or requested to do by Government or by the Agent, he would do nothing whatever if only advice were offered to him on the subject. It appears to me to be a question that a Forest Act alone can deal with; Government have to consider the future welfare of the country even if so remote a time as two or three centuries hence is considered; and they have also to legislate that the water-supply of rivers is not tampered with,

which is here certainly threatened. The Raja, or any other private proprietor in a similar case, only looks to the present and to immediate profits, and laughs at what may or may not occur a century hence.

17. In a forest point of view, my tour was most instructive and interesting. I have never before fully realized the great damage done by fire in our forests, nor the great value of the deposition of humus. Here it was exemplified in every stage by numerous tracts. Hill-side forests, just felled and burnt and under cultivation, with the denudation of soil caused by a heavy monsoon in the absence of a leaf-canopy in many cases very clearly shown; the regrowth from coppice of these tracts in the younger stages up to twelve or fifteen years when they are dry and arid with much grass and rank growth; and again the older stages up to forty or fifty years when the deposition of humus gives vigor to the tree-growth and moisture to the soil seedlings re-appearing amongst the coppice, the undergrowth gradually changing its character, and land shells, Uropeltidœ (earth snakes), and frogs appearing. I was much disappointed at not finding any really virgin forests, though I went up to some of the highest and least accessible places to look for it. Everywhere the forest had been felled, as I have already explained, within a period of fifty years. Botanically, my tour was of very little interest. I had expected much novelty; but, as far as I was able to observe the vegetation, it was quite similar to that of the Golcondah hills, a little further south, which I explored in 1870.* I was, however, upon these hills at a most unfavorable time. The north-east monsoon, except for one heavy shower at the time of the cyclone at Vizagapatam, had been a complete failure, and the country was unusually dried up. There were only some eight trees in flower at the period of my visit, and all herbaceous plants were entirely dried up, except in some of the moister parts where a few acanthaceous plants (*Strobilanthes, Stenosiphonium, Hemigraphis, and Hemiadelphus*) and a few com-

* *Vide* G.O., dated 1st April 1870, No. 426.

Anogeissus acuminatus.
Bauhinea variegata.
Boswellia glabra.
Buchanania latifolia.
Casearia tomentosa.
Pterospermum Heyneanum.
Soymida febrifuga (in bud only).
Sterculia villosa.

mon Compositœ, were in blossom. I observed, however, several trees and two or three creepers that were unknown to me, but these had no sign of flower or fruit. *Caryota urens*, a fine palm, is abundant, and ferns are very plentiful in the older forests, but quite similar to those on the Golcondah hills, several being of a Burmese type. The fine tree fern *Cyathea spinulosa* grows to a very large size. I did not anywhere get to an elevation exceeding 4,300 or 4,400 feet, and I was much disappointed at not being able to visit some of the higher peaks in Hill Madgole which rise above 5,000 feet (Arma being, by Colonel Saxton's map, 5,500). Except in very small patches there is no tree vegetation on these much above 4,000 feet, so there was no real necessity for my visiting them; and when I found that it would rather inconvenience Captain Blaxland, I gave it up, and it was rather fortunate that I did, for very wet weather set in over all this higher portion of the table-land in the middle of January, just the time we should have been there.

18. *The Malcangiri Taluq.*—This is quite down in the plains (elevation 600 to 800 feet), an oblong of about 80 miles long by 25 broad, the area being about 500 square miles, situate between the rivers Silaru and Saveri. I descended into it expecting to find it all fine forest, but I was sadly disappointed. About Sikkapilly and Akuru some 15 to 20 miles north of Malcangiri (or 18·40 north latitude), there are a few patches of fine Teak (probably not exceeding 300 or 400 acres) which have apparently never been touched by the axe of the Kumari cultivators, and a good deal of Teak forest that has been more or less destroyed; but to the south of this, or in the more accessible portions of the taluq, there is no Teak or Sal (*Shorea robusta*) whatever, and no forest to speak of, though of course there are isolated fine trees about the river-banks; between Malcangiri and Moat (the most southern point of the taluq where the two rivers join and form the Saveri) all the forest is of poor, stunted growth, having been quite ruined by many rotations of felling and burning for cultivation, and it is doubtful if any of this portion, even if now reserved, could recover; at any rate, it would take a very long time to do so. North of the small Teak tract alluded to, or about 18·40 north latitude,

fine Sal forest is entered, and this stretches away and forms fine tracts as far as Raighar, at the extreme north-east portion of the Jeypore Zemindari. Here again everywhere the Kumari cultivator's axe is at work, and I could not find anywhere a single acre of really virgin Sal forest. Sal, however, seems soon to recover, at least in the first rotations of this felling and burning; the stools grow again rapidly and seedlings quickly germinate, but the forest must suffer at each rotation, and in course of time become very poor; and as the system is evidently in force over the whole length and breadth of the Sal country, the forest must be deteriorating at an equal ratio. I only visited the southern portion of this Sal country, as I did not think it necessary to go all over it, nor would time have allowed me to do so. I saw many hundreds of acres under bare burnt poles where cultivation is going on or had just been deserted, and tracts of Sal of different ages up to probably forty or fifty years. These tracts are so considerable, and the population so sparse, that the forest is probably always given a long rest before it is again felled. In the older tracts, there were a good many trees about 6 feet in girth, and here and there a few 8 or 9 feet; but these girths are very small to what would be met with if there were virgin tracts to be found. When a tract is being prepared for cultivation, I always observed that a few trees were left uninjured, and this accounts for the larger trees alluded to. Before firing, all the smaller trees are felled, and a few of the larger ones; the rest, with the exception of a few trees here and there, are all deeply ringed. I thought perhaps that the native was provident enough to leave the few standing trees to ensure a supply of seed; but on making inquiries, it appeared that they are only left to save trouble, as a small amount of shade does not injure the cultivation. Captain Blaxland informed me that the same system was going on up to his extreme northern limit, that he could ride nowhere without seeing hundreds of acres of bare burnt poles. In the north, I was informed that a system largely prevails of destroying the tree for the sake of its dammar; this is not carried on in the south at least to any extent.

19. There is no export demand whatever for this Sal; in fact, it would not pay to get it out; it would have to be carted

to Malcangiri before it could be floated, and then the floating would be very expensive, as the timber will not float without bamboo rafts or canoes; nevertheless, it is a thousand pities that this reckless system of destruction should go on, when the tracts are so large that there is ample room for the reservation of at least one quarter without probably any inconvenience to *the cultivators.* A market will some day arise, and then it will be found that all the forest has been destroyed or reduced more or less to a stunted type, whereas with reservation, there would be fine tracts with giant trees.

20. I was assured by the Sub-Magistrate that it would never pay to attempt to work the Teak down to the Godavery, and I do not believe myself that it would; but there are so few trees fit for felling that it is not worth consideration. Some were felled and carted to Jeypore and Koraput not long ago for building purposes at those places. All the Teak tracts should, however, be strictly reserved against Kumari cultivation, and I believe the Raja has given orders to this effect, but how far they are acted up to is doubtful.

21. With the exception of the grass flats (here called behras), which are swamps in the rains, and the haunts of the wild buffalo, all this taluq has been at no very distant date fine dense forest; the latter is rapidly disappearing, and under the present system, it must become more and more stunted, till in time it will cease to exist; the climate, of course, becoming more and more arid as this destruction progresses.

22. About 1856 Mr. Tuke explored these forests and reported on them; and prior to his visit, Captain Fenwick traversed them, and I believe reported to Government I have been unable to obtain copies either of these reports, but Mr. Glasford, Deputy Commissioner, in his report on the dependency of Bustar (Selections from the Records of the Government of India in the Foreign Department, No. 39, page 66), states that Captain Fenwick's report was not very favorable, but that Mr. Tuke brought back a better account. When I was in the Godavery forests in 1857, I heard that Mr. Tuke had felled a quantity of Teak logs up the Saveri river, but that they had been left there because it would not pay to get them down. Captain Blaxland told me that these

logs were lying at Moat a year or two ago, and that they had been felled there; this latter is evidently an error, as there is no Teak anywhere near Moat, or any sign of there ever having been any. The logs have now disappeared, and from what I could learn, they were most probably felled in the Soonkom Taluq of Bustar just opposite Malcangiri, but it is possible they were felled in the Teak tract that I have alluded to, north of Malcangiri.

23. There are large Teak forests in Sookom and in several other tracts of Bustar, and large quantities of Teak are annually brought down the lower portion of the Saveri where it is navigable. The size of this timber has lately been decreasing annually, and though a few large logs now came down, it is mostly small stuff.

24. The river Silaru is nowhere navigable, and the forests in its valley have been terribly destroyed; they all appear to have been cut over every eleven or twelve years for probably very many rotations, and are now of the poorest description.

25. It is very evident that it would not be advisable for Government to undertake the working of the forests of the Malcangiri Taluq. In a climatic point of view, their entire disappearance is of very small importance compared to that of the forests on the uplands; they are in the plains, and there is little or no denudation of soil attending the constant fellings, and their destruction does not threaten the water-supply of the Godavery at least to any extent, so it is doubtful whether Government are called upon to interfere in any way, although there can be no doubt that a fine forest country is gradually being denuded of woodland, and a climate gradually being made more and more arid. It would be an excellent thing for the country if the Raja could reserve one-fourth or one-fifth of the Sal forest against all felling and burning for cultivation, and the whole of the small Teak tract, besides making other reservation against the same ruinous system down south of Malcangiri where all forest is disappearing as fast as it can, and he might be advised on this subject; but he probably would not listen to advice, and it might be said that we were preaching what we do not practise ourselves, as our own Reserves are few and far between, and our own forests are disappearing in many districts.

26. The Raja should also keep a Forest Darogah or Forester in this taluq to look after his interests. There is ample to pay for a small establishment of this nature, which might be under the Sub-Magistrate, Mr. Jangum, a very intelligent and exceedingly civil official.

27. I did not attempt to visit the Sal forests about Rayagudda on the north-east corner of Jeypore; they are quite without Captain Blaxland's range, and I did not look upon the orders of Government or the Revenue Board as requiring me to go in that direction. These forests are, however, nearer a market, and more likely to pay than any of those that I inspected; and I believe that they are worked, and that the Raja derives a revenue from them. They adjoin the Purlakimedy forests now under the Court of Wards, where a forest ranger from this department is in temporary charge, and if Government think it necessary, I can arrange for his visiting and reporting on these tracts.

28. I forward herewith a list of the trees that I found growing in the Jeypore country, arranged in their natural orders. There were a few trees that I was unable to identify; and, as I have already explained, none hardly were in flower, and I had no opportunity of collecting anything of interest.

29. I regret that this report has been somewhat delayed, but about ten days after I left the Jeypore forests, and whilst on inspection in the lately handed over districts of Godavery, I was floored with jungle fever which I have been unable hitherto to shake off, and I have had some difficulty in getting through my routine work and correspondence.

30. The forests of the Bustar dependency are, I believe, of far greater value than anything in Jeypore; from all I could learn great destruction is going on in them.

List of Trees growing in the Zemindari of Jeypore.
(NOTE.—Pl. for Plateau only).

Botanical Names.	Telugu.	Uria.
Dilleniaceæ.		
Dillenia pentagyna	China Kalinga ...	Rai.
Magnoliaceæ.		
Michelia champaca Pl.	Champa	Champa.
Anonaceæ.		
Polyalthia cerasoides	Chilka dudagu ...	...
Do. korinta	...	...
Do. suberosa, Pl.	...	...
Anona reticulata, Pl.	...	...
Miliusa velutina	Pedda Chilka dudagu ...	...
Saccopetalum tomentosum	...	...
Alphonsea sp., Pl	...	...
Capparideæ.		
Niebuhria linearis	... ...	...
Cratoeva religiosa	Uskia	...
Capparis grandis	Reyguta	...
Bixineæ.		
Cochlospermum Gossypium ...	Goongoo	...
Flacourtia sp.	... ...	Bonicha.
Dipterocarpeæ.		
Shorea robusta	Googal	Salwa.
Malvaceæ.		
Thespesia populnea	Ganga ravi... ...	...
Kydia calycina	Pandikee	Ropasia.
Bombax Malabaricum	Boorga	Bours.
Sterculiaceæ.		
Sterculia urens	Thubisee	Kavili.
Do. Guthala	...	...
Pterospermum Heyneanum ...	Lolugi ...	Baelo.
Tiliaceæ.		
Grewia excelsa	...	Kulo.
Do. asiatica	......	......
Do. pilosa...	......	......
Do. lævigata	......	......
Do. abuitilæfolia	......	......
Do. tilæfolia...	Charachi	Dhomous.
Rutaceæ.		
Zanthoxylum alatum, Pl.	......	......
Do. Rhetsa, Pl.	Rhetsa	......
Limonia acidissima	Torelega	Behenta.
Citrus sp. Pl., ...	......	Ambeletoba.
Feronia elephantum	Velaga	Kœto.
Ægle Marmelos...	Maredu	Bellu.

Botanical Names.	Telugu.	Uria.
Burseraceæ.		
Boswellia serrata	Anduga	......
Garuga pinnata...	Garuga	Mohi.
Meliaceæ.		
Melia azadirachta	Vepa	......
Do. azedarach	Taraku vepa ...	......
Aglaia Roxburgiana	......	......
Walsura ternata...	......	......
Soymida febrifuga	Sumi	Sohau.
Cedrela toona	Toon	Maha limbu.
Chloroxylon Swietenia	Billu	Behru.
Celastrineæ.		
Elœodendron glaucum	Neradi and bootigi ...	......
Gymnospora montana	Danti	......
Rhamneæ.		
Zizyphus jujuba	Rengha	......
Do. Nummularia	......	......
Do. Oenoplia	......	Barokolee.
Do. xylopyrus	Gote	......
Sapindaceæ.		
Hemigyrosa canescens	Korivi	......
Erioglossum edule	Iscarasee	Mukta moya.
Schleichera trijuga	Puska	Rusam.
? n. Sp.	......	......
Sapindus trifoliatus	*Konkudu*	*Rettia.*
Nephelium longana	Poova	......
Sabiaceæ.		
Meliosma simplicifolia, Pl., ...	......	......
Anacardiaceæ.		
Mangifera Indica	Mamidi	......
Buchanania latifolia	Chara	Charu.
Odina Wodier	Gumpina	......
Semecarpus Anacardium	Jiri	Ballia.
Spondias mangifera	Amatom	Amra.
Moringeæ.		
Moringa pterygosperma	Mooraga	Munigha.
Leguminosæ.		
Indigofera pulchella	......	......
Ougeinia dalbergioides, Pl.... ...	Tella motku... ...	Bondhona.
Erythrina Indica	Modugu	Chaldua.
Do. Suberosa	Tella modugu ...	......
Butea frondosa	Modugu	Polasu.
Dalbergia latifolia	Jitegee	Sissua.
Do. lanceolaria	Pedda Soparu ...	......
Pterocarpus Marsupium	*Yeggi*	*Byasa.*
Pongamia glabra	Kanuga	Koranju.
Cassia fistula	Reylu	Sundari.
Hardiwickia binata	Nar yepi	......

Botanical Names.	Telugu.	Uria.
Leguminosæ.—(Contd.)		
Saraca Indica, Pl.	Asok	Asok.
Tamarindus Indica	Chinta	......
Bauhinia racemosa	Ari	Ambota.
Do. Malabarica, Pl.	Puli shinta	......
Do. variegata	......	Borara.
Do. purpurea, Pl.	Kanchan	......
Do. retusa, Pl.	......	......
Xylia Dolabriformis	Konda tangœdu ...	Boja.
Prosopis spicigera	Chami	Shami.
Dichrostachys cinerea	Vetura	......
Acacia Arabica	Nalla tumma ...	Babul.
Do. leucophlea	Tella tumma ...	......
Do. Catechu	Sandra	Khoiru.
Do. Ferruginea	Ansandia	......
Do. Suma	......	Gonharea.
Albizzia Lebbek...	Duchirram	Seris.
Do. odoratissima	Chindagu	......
Do. stipulata, Pl.	Konda Chindagu ...	......
Do. procera...	Tella do. ...	Sarapatri.
Do. amara	Regu	......
Combretaceæ.		
Terminalia tomentosa	Nalla-maddi ...	Saj.
Do. arjuna	Airu do.	......
Do. belerica	Thani	Bhara.
Do. Catappa	Vadam	Badam.
Do. Chebula	Karaku	Karedha.
Anogeissus latifolius	Chiriman	Dhobu.
Do. acuminatus	Pashi	Panchi.
Gyrocarpus jacquini	Kumar pulki ...	......
Myrtaceæ.		
Eugenia Jambolana	Naror	......
Do. alternifolia	Manchi Moyadi ...	......
Do. Salicifolia?	lina	......
Do. sp., Pl.	......	......
Do. Caryophyllifolia	Bata-jania	......
Barringtonia acutangula	Kurpa	Kinjolo.
Careya arborea	Buda-darmee ...	Kumbli.
Melastomaceæ.		
Memecylon umbellatum	Allí	......
Lythrarieæ.		
Woodfordia tomentosa	Jarji	Jatiko.
Lagerstrœmia parviflora	Chinangi	Salora.
Samydaceæ.		
Casearia tomentosa	Wasa	Girari.
Do. esculenta?	......	......
Araliaceæ.		
Heptapleurum, sp., Pl.	......	......
Cornaceæ.		
Alangium decapetalum	Udagu	Akola.

Botanical Names.	Telugu.	Uria.
Rubiaceæ.		
Adina cordifolia...	Bandaru	Holonda.
Stephegyne parvifolia	Nir kadamba and Bata ganapu	......
Hymenodyctyon excelsum.... ...	Chetippa	Bodoka.
Wendlandia tinctoria	......	......
Do. exserta	......	......
Randia uliginosa	Nalla kakisba ..	Pendra.
Do. sp.	......	......
Gardenia lucida...	Tellamanga	Karinga.
Do. gummifera	Gaggaru	......
Do. latifolia	......	Kota ranga.
Plectronia didyma	Nalla balsu	......
Ixora parviflora...	Karipal	......
Do. barbata	......	......
Pavetta Indica	......	......
Do. tomentosa	......	......
Morinda bracteata	Maddi ...	......
Do. exserta	Togaru mogali ...	Achu.
Hamiltonia suaveolens	......	......
Sapotaceæ.		
Bassia latifolia	Ippi	Moha.
Mimusops elengi	Pogada	......
Do. hexandra	Pala	......
Ebenaceæ.		
Diospyros ebenum	Tumbi	Khenda.
Do. melanoxylon	Timkee	Tenda.
Do. embryopteris.	Kiriki	Gano.
Do. cordifolia	Vackana	......
Do. montana	Muchi timki ...	......
Do. ovalifolia	......	......
Do. Sylvatica	Tella goda	Kaloochia.
Styraceæ.		
Symplocos spicata	......	......
Oleaceæ.		
Nyctanthes arbortristis	......	Gongo sheoli.
Schrebera swietenioides	Makkam	Juntia.
Olea Roxburghiana	......	......
Do. sp.	......	......
Apocynaceæ.		
Plumeria acutifolia	......	......
Wrightea tinctoria	Tella pal	......
Do. tomentosa	......	......
Holarrhena antidysenterica ...	......	......
Loganiaceæ.		
Fragrœa Coromandelina	......	......
Strychnos nux vomica	Mushti	Kerra.
Do. potatorum	Chilla	Kotaku.

Botanical Names.	Telugu.	Uria.
Boraginaceæ.		
Cordia myxa ...	Pedda boko...	Gondi.
Do. polygama	Bokn	......
Ehretia lœvis ...	Paldatum ...	Mosonea.
Do. aspera ...	......	......
Bignoniaceæ.		
Dolichandrone falcata	Wodi	......
Heterophragma tetralocularis	Kala gore ...	......
Stereospermum chelonoides	Kola goru ...	......
Stereospermum suaveolens ...	Peda Kolagore	Patuli.
Stereospermum xylocarpa ...	......	......
Oroxylum Indicum	Pamania ...	Pomponia.
Verbenaceæ.		
Tectona grandis...	Tek ...	Singuru.
Gmelina arborea	Pedda gomru	Goombari.
Vitex altissima ...	......	......
Do. pubescens	Nowli Cragoo	......
Premna tomentosa	Nowra ...	......
Callicarpa lanata	......	......
Salicaceæ.		
Salix terasperma	......	......
Laurineæ.		
Machilus macrantha, Pl. ...	......	......
Tetranthera laurifolia, Pl. ...	......	......
Do. ? Bl. ...	......	......
Litsæa Zeylanica Pl.	......	......
Do. ? Pl.	......	......
Do. ? Pl.	......	......
Do. ? Pl.	......	......
Euphorbiaceæ.		
Phyllanthus reticulatus	......	......
Do. emblica	Oosri ...	Ohalu.
Glochidion sp. Pl.	......	......
PutranjivaRoxburghii, Pl. ...	Kudra jinie	......
Hemicyclia sepiaria	......	......
Antidesma diandrum, Pl. ...	......	......
Briedelia retusa...	Kora man ...	Kosi.
Cleistanthus patulus	Pansodi ...	......
Lebidieropsis orbicularis	Vodesha ...	Karada.
Trewia nudiflora	......	......
Mallotus Philippinensis	......	Kumala.
Homonoya riparia	......	......
Do. retusa	......	......
Givotia rottleriformis	Tella punki ..	......
Gelonium lanceolatum	......	Kakra.
Euphorbia Cattimandoo	......	......
Urticeæ.		
Ulmus integrifolia	Pedda nowli eragu	......
Celtis Roxburghii	......	......
Do. Whightii ...	......	......
Sponia Whightii	Gadda nelli...	......
Artocarpus integrifolia	......	Panasa.
Do. lakoocha ? Pl. ...	......	......

Botanical Names.	Telugu.	Uria.
Urticeæ.—(Contd.)		
Streblus aspera	Baranki	......
Taxotrophis Roxburghii	......	......
Ficus religiosa	Rai	Peepal.
Do. Bengalensis	Mari	Boru.
Do. tomentosa	......	......
Do. glomerata	Moydi	Dimeri.
Do, ampelos	......	Karsau.
Do. tsiela	Juvi	Jari.
Do. retusa	......	......
Do. asperima	......	......
Do. Cunia, Pl.	......	......
Do. sp.	......	......
Do. sp.	......	......
Oreocnide sylvatica, Pl.	......	......
Cycadaceæ.		
Cycas revoluta?	......	......
Palmeæ.		
Calamus sp., Pl.	......	......
Do. sp.	......	......
Phœnix sp.	......	......
Do. sp.	......	......
Borassus flabelliformis	......	......
Cocos nucifera	......	......
Caryota urens	Mardi	Salopo.
Gramineæ.		
Bambusa arundinacea	......	......
Do. Spinosa?	......	......
Dendrocalamus strictus	......	......

(Sd.) R. H. BEDDOME, *Lieut.-Colonel,*
Conservator of Forests.

Report on the Impregnation of Timber.

BY DR. H. WARTH.

AFTER having written a pamphlet on the impregnation of timber, under the orders of Dr. Brandis, the Inspector General of Forests, East India, which was read at the Simla Forest Conference in October 1875, I received orders from the Under-Secretary of State for India to make a journey on the Continent of Europe, and to gather information about the present state of this industry.

The following contains,—

1. An account of the journey.
2. A résume of the general results.
3. The answers to Dr. Brandis' special questions.

1. *Account of the Journey.*

I made this journey during the month of November 1876. The following is the account of what I saw during the journey. For general descriptions of the processes I can refer to the above-mentioned pamphlet, and to the books and extracts which I have the honour to forward with this report.

In England, the creosoting according to Bethell's method is at present almost exclusively used for railway sleepers. I was at the works of Messrs. Burt, Bulton, and Haywood, at Rotherhithe, London, on the 28th of September 1876. In their yard are three large creosoting cylinders, each of 80 feet length. The pressure with which the creosote is forced into the wood in the cylinder is 150 pounds per square inch. The yard is provided with a net of tramways. On these run trollies with wheels of $2\frac{1}{2}$ feet diameter, and on the trollies rest the iron frames which hold the sleepers. These frames have again wheels of $\frac{1}{2}$ foot diameter, by means of which they can be run into and out of the cylinders. Along the bottoms of the cylinders tubes are laid for heating the creosote with steam. I observed a cylinder which had just been opened after the process was over. Whilst the creosoted sleepers on the frames were still in the cylinder and were left cooling, white snowy crystals were forming on the upper part of the inner surface of the cylinder. They were probably naphtaline. While the cylinders are in the state of exhaustion valves are opened at the bottom, which allow the creosote to rush in through tubes from the reservoirs close to the cylinders. The filling takes place in this manner, without the use of ony other but the air-pump, although the reservoirs are all in the ground, lower than the cylinder. Great quantities of creosoted sleepers have been sent from the place to India. The London and South-western take also many creosoted sleepers from here. The London and North-western have their own creosoting works. I saw one when passing in the train near Willesden Junction. The London and South-eastern Railway prepare sleepers by soaking them in summer, whilst they are as much as possible air-dry, in a warm mixture of tar and creosote oil. I also went to the office of Sir William Burnett and Co. in London, and received their

printed instructions and certificates, which I forward. (Appendices I and II.)

They told me that their pneumatic apparatus were absolutely the same as those in use in creosoting. Besides the pneumatic process of impregnating with their patent chloride of zinc solution, they recommend also the mere soaking of the timber in the solution. In many cases Burnettizing must be resorted *to because there are objections to the creosote. For instance,* wood for building cannot at all be creosoted. It would not only have a bad appearance and smell, but be highly inflammable. The chloride of zinc, when used in large quantity, renders on the contrary wood to a great extent uninflammable. *Very interesting, as a proof of the beneficial effect of* Sir W. Burnett's process, is the durability of cloth and cordage impregnated with chloride of zinc.

In Germany I went at first to see the impregnation works at Gustavsburg, near Mainz. There are two works, one belongs to the Hessische Ludwigsbahn Company, and the other to the firm of W. O. Waldthausen Wilh. Sohn, of Cologne. The Company's works are for kyanizing. The sleepers are soaked in the solution in wooden cisterns. They are first piled up in the empty cisterns, and the solution is pumped in afterwards. The consumption of corrosive sublimate is as follows :—

Fifteen cubic feet of wood take one pound of sublimate, thus one sleeper would take about 0·2 pounds of sublimate. At the time of my stay the work was at a standstill. The person in charge thought the high price of the sublimate had caused the engineers to stop the process for the time. The price of sublimate was, however, highest three years ago. Then, in 1873, it cost 672*l.* per ton, whilst in November 1876 it cost only 260*l.* per ton. The other work, which belongs to the private firm of Waldthausen, in Cologne, continued to impregnate sleepers with creosote by the pneumatic process. *The material used is* a mixture of common coal tar, with 10 per cent. of raw creosote. Besides the large tar reservoir there is a small one which serves to indicate the quantity of tar pressed into the wood, the force pump taking the tar from that reservoir. A

steam engine drives the water pumps, tar pumps, and the air pumps. The valves of the latter are conical brass valves. The manager finds himself sometimes in difficulty, owing to the different quantity of tar which differently grown pieces of wood take up. He is expected to give a certain equal quantity of tar to the sleepers, and yet wood of the same kind, if grown more open, will take up two and a half times as much tar as more densely grown wood. The length of the pneumatic boiler is 36 feet. Pressure, 100 pounds per square inch. The exhaustion lasts as long with oak as with fir, half an hour pumping and half an hour standing. I was told that the Hessische Ludwigsbahn use no sleepers whatever without their being impregnated.

At these works two gentlemen have called in 1874, who said they came from East India, and were railway engineers.

From Cologne I went to a place called Nippes, two miles from Cologne. There are impregnation works for creosoting railway sleepers and telegraph posts.

They have two cylinders of 34 feet length each. The sleepers are oak, and the telegraph posts are pine. The oak sleepers are first left to season for two months under cover. After this they are heated to 190 degrees in a smoke stove. This stove is a house divided into four compartments, each of which is connected by a subterranean passage with a furnace. Four furnaces are together in a hollow below the floor of the stove house, and coke is burnt in them. The gases of combustion enter the respective compartments, which are fitted with draught holes for the exit of the damp smoke. They also have iron doors. The drying process cracks the oak sleepers a great deal. These cracks appear not to be objected to, inasmuch as they facilitate the entry of the tar oil and creosote into the wood, whilst they themselves are rendered harmless by being filled up with the pitch contained in the tar. The creosote comes from a factory in Bochune, and it is mixed with tar, which is obtained at Cologne or other places in the neighbourhood. I saw telegraph poles ready creosoted. They had a shining surface from hardened pitch. I saw such telegraph poles in use at Düsseldorf. The pressure applied 116 lbs.

per square inch; and I was told that in one day one thousand sleepers could be prepared with two cylinders, the 22-horse power steam engine driving the pumps. The cylinders, lids, filling wagons, &c., are the same as usual.

The State railways of Hanover have four impregnation works, one in the town of Hanover, with only one impregnation cylinder, and three at other places, with two cylinders each. In all of them the Burnett process is practised upon oak sleepers. I saw the process carried on in the town of Hanover. The boiler has a semi-spherical lid of the same material as the boiler itself, and the whole arrangement is the same as with the creosoting apparatus. There is no special steam engine, but the pumps are attached to the engine of the adjoining workshops. The boiler of the latter supplies also the steam for steaming the sleepers. The cylinder is, as a rule, filled twice during one day. Whilst I was there the process was only once gone through. The sleepers were left under pressure during the whole night, and taken out in the morning. The impregnating fluid had become black from the iron and the sap of the sleepers. I submit a sample of prepared oak in which the colouring matter is seen to have penetrated. Considerable time is taken up by the steaming of the sleepers. After the steaming, the condensed water is permitted to run off, and with it as much sap as the steam has extracted from the wood. The following evacuation of the air from the cylinder and the interior of the wood does not, as might be suspected, cause an extraction of condensed water and sap from the damp wood. If such were the case, a removal of fluid would have to take place at the end of the air pumping. I have inquired about this circumstance, and have been told that when, through accident, it became necessary to open the boiler at the particular state of the process after the evacuation of the air, it was found that the wood was dry, and no sap or condensed water had accumulated in the boiler. It thus appears that what condensed water is imbibed by the wood during the steaming is mostly evaporated, and does not collect at the bottom of the boiler. Inspector Ebers, who complains generally about the want of information and

systematic experiments on different methods of impregnation, expressed his doubts about the usefulness of the steaming. He says very little sap was extracted through the steaming, whilst the wood became damp, and thus less capable of imbibing the impregnating fluid. I believe that those who introduced the method of steaming the wood before the impregnation, found that the steaming opened the way for the entry of the fluid into the hard wood somewhat in the way as the artificial drying or smoking process. Inspector Ebers drew my attention to the excellent results which were obtained with *P. sylvestris* sleepers, which he impregnated many years ago. He used chloride of zinc and the pneumatic process, but he did not steam the wood. After 17 years' use only nine per cent. of these sleepers had become so bad as to require removal. This was not at Hanover, but on the line between Emden and Rhine.

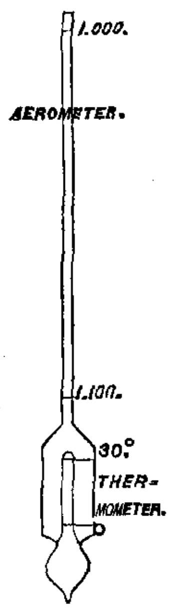
I was given two descriptions of the process of impregnation at Hanover, which I forward (Appendices III. and IV.) As regards the duration of the sleepers on the Hanover State Railways, I must refer to the report which was laid before the assembly of German and Austrian Railway Engineers in 1868, and about which I will speak afterwards. The chloride of zinc is obtained in glass flasks (*korbflaschen*) as a solution. The conditions are, that it must contain 25 per cent. of metallic zinc, must not be acid, must not be strongly colored, must have no sediment, must not contain more than one per cent. of iron and have a specific gravity of 1·61 to 1·62.

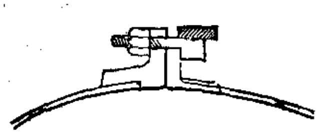
At Hanover I was also told that the Cologne-Minden Railway had lately abandoned the pneumatic creosoting, and had begun to use chloride of zinc. They had found that their results with creosote were not essentially superior to the results obtained at Hanover with chloride of zinc, whilst the latter was so very much cheaper that the change was desirable.

After my visit to Hanover I saw the impregnation works at Braunschweig. Most of the sleepers which were impregnated at the time were oak sleepers. There were but a few beech sleepers. They and the oak sleepers in store are behaving well, except that the beech sleepers crack a good deal. There

are *P. sylvestris* sleepers, which I was told dry with difficulty, but do not show rot nor any trace of fungus. They used formerly to impregnate with a solution containing one part of commercial chloride of zinc solution and 30 parts of water. With this strong solution it was observed that sleepers decomposed at the places of contact with the rails and iron nails. I also have heard that the solution was at times found to contain an excess of acid, and it may be that the impurity of the solution had to do with the mischief. It was found advisable to reduce the strength of the solution, so that 50 parts of water are now added to one part of the commercial solution.

The latter contains by agreement 25 per cent. of metallic zinc. The mixing takes place in a wooden tank of 6 feet diameter. One of the glass flasks in which the fluid comes from the chemical work is mixed with a known quantity of water in the tank, and thus the proper mixture is as a rule obtained. They also have an





aerometer which gives the specific gravity and, by a written scale, the contents. Regard is had to the temperature of the fluid during the observation. The aerometer is at the same time a thermometer. This is very convenient, and was novel to me. I forward a copy of the scale of specific gravities, which is of course only correct for a certain quality of chloride of zinc, but it will do for all kinds approximately, (Appendix V.) The customary wagons which are run into the cylinders are here used for the transport about the yard, without being placed upon other wagons with larger wheels. The cylinders, two in number, have large diameters, about 2 metres,

and the iron is very thick, about ⅜ inch. A precaution is used here in order to prevent a loosening of the screw bolts at the lid. A hoop is drawn all over, so that their bent ends cannot (as has happened) draw themselves outwards during the great pressure. Once the lid broke loose during the operation, and was thrown a distance of 12 yards. Before the exhaustion steaming takes place in the same way as at Hanover, only it takes less time, because at Braunschweig there is a special boiler and engine for this work, whilst at Hanover the boiler and engine of a workshop are used. The pressure during steaming does not exceed 14 lbs. per square inch. After the steaming the sap and condensed water are run off. I was assured that, during the subsequent process of *evacuation, no appreciable collection of sap from* the wood takes place, and the wood becomes quite dry to the appearance. It is, therefore, quite correct to proceed at once after the exhaustion to the admission of the impregnation fluid. The process was commenced in the year 1851, and the engine came from Borsig, in Berlin. The original steam boiler even is still in use. The engine drives a force pump for the steam boiler, a pump for forcing the fluid into the cylinder, a common water pump, and an air pump. The latter is so constructed that the piston moves in a horizontal cylinder which is filled with water. The valves for the air are of india-rubber.

I forward a statement of the cost of the process (Appendix VI); also a statement showing the behaviour of the sleepers on three different Braunschweig lines (Appendix VII).

Further I forward, in original, the statements of the interesting experiments which have been made at Braunschweig with natural and impregnated sleepers of different kinds of wood. (Appendices VIII to XIV). The experiments were begun in the year 1857, and Appendix VIII is a detailed report about the state of the sleepers up to the year 1867. These valuable experiments have lasted 17 years. The sleepers were impregnated at Braunschweig with the pneumatic apparatus, partly with the stronger solution, which was formerly in use, and partly with the weaker solution, which is now used. The purpose of the experiments was not only to determine the relative

durability of the unimpregnated and the impregnated sleepers, but also to determine the influence of the contact of the sleepers with the iron of the bedding of the sleepers, of the strength of the solution, and of the shorter or longer interval which elapsed between the impregnation and the exposure of the sleepers in the ground. As regards the first purpose the result was a highly satisfactory one.

After 16 years' observation, the durability was found or estimated as follows :—

	Natural.	Impregnated.
Oak ...	12 ...	19
Beech ...	4 ...	18
Pinus sylvestris	6 ...	15

As regards the other influences, the experiment did not show much. Especially when the behaviour of the sleepers is observed up to the time when they became quite useless, general rules are scarcely traceable, owing to the great variations amongst a limited number of samples. If the behaviour of the sleepers up to 10 years only is considered, one may, with a small degree of safety, deduce that the contact with iron was injurious, whilst complete bedding or covering, strong solution, and a longer interval after the impregnation were favourable; *Pinus sylvestris*, however, behaving, as regards the bedding and as regards the strength of the solution, reversedly from oak and beech. Compared with the uncertainty which prevails with regard to these minor influences, the great difference between unimpregnated and impregnated sleepers becomes only so much more striking.

The Boucherie process is used near Dresden by the Imperial Telegraph Department for impregnating telegraph poles of pine wood. I have not been on the spot, but I was told by a telegraph officer that each pole takes 14 days to be impregnated. The operation commences within not more than 10 days after felling. The impregnation of one pole costs 2*s.* 6*d.*, or, in this case, half the original price of the pole.

When travelling from Vienna to Laibach, I passed the station of Krieglak. Close to this station is a timber yard, where the impregnation is practised according to Boucherie's method.

Chiefly telegraph posts are impregnated here. They are of pine wood, and specially fit for this process. Any timber which is used round in the original form of the tree suits the Boucherie process well. Moreover, these telegraph posts are all young wood, and take up a great quantity of solution. The impregnation works belong to the town of Krieglak. There are two vats about 10 metres above the ground upon a scaffolding, and from these pipes are conveyed over the yard. The sleepers of the line at Murzzuschlag are impregnated larch and beechwood. Further on, in the direction of Trieste, the beech sleepers are used which are impregnated at Salloch, near Laibach. The station of Salloch is the first or second halting place in the direction from Laibach to Vienna. Here are the impregnation Werkstätten which prepare beech sleepers with solution of copper vitriol by means of pneumatic process. From these works, the K. K. Südbahn is supplied, and the Alta-Italia Railway have also had their sleepers impregnated there. There is a large yard, which contained close to 100,000 beech sleepers at the time of my visit. The lines of rails which go over the yard have the same gauge as the big railway line. On these rails small wagons are run, which convey the sleepers to and from the impregnating cylinder. The sleepers are laid upon frames which rest upon the wagons. The longer side pieces of these frames are made of wood, and the crosspieces at both ends are heavy pieces of bronze. The frames have also rollers of bronze, by means of which they can be rolled from the wagons on which they rest into the impregnation cylinder. There are no arms attached to the frames for holding the sleepers, but the latter are held to the frames by means of ropes. The men have acquired practice in piling the sleepers with the outline which suits the cylinder. There is only one cylinder. It is 6 feet in diameter, and takes up three lengths of sleepers. It is made of copper of $\frac{3}{8}$ inch thickness, and iron rings are screwed over it of $1\frac{1}{4}''$ by $4''$ section, one occurring at every two feet length. There are six bronze frames, so that while three are used in the boiler with the sleepers upon them, the other three are employed in disposing of finished sleepers and collecting fresh ones. The lid is likewise of copper, screwed to the cylinder in the usual

manner. Tallow and hemp are the substances used for tightening. The bolts, by means of which the lid is held to the cylinder, are struck through holes in the projecting rim of the cylinder, so that they do not require removing altogether when the lid is taken off, but the screws have merely to be loosened a little, and then the bolts can be turned with their bent ends outwards, in which position they are no more in the way. Two large water glasses, one higher up, one lower down, are attached to the cylinder, so that the height to which the fluid has risen can be observed conveniently. A transportable engine and boiler works the whole. There is a separate air pump and a separate compressing pump. The pumps must all be in first rate order, because, during the working season, they have to go with little interruption day and night. It is astonishing that they are making not less than 12 repetitions of the process in 24 hours, and not only do they extract the air and compress the fluid to six atmospheres' pressure, but they steam the sleepers also. The process is thus repeated six times as often with this one cylinder than it is with the single cylinder at Hanover. The increased number of charges compensates fully for the high price of the copper cylinder. The sulphate of copper solution is prepared and kept in round wooden vats. Five sleepers are weighed before and after each operation, and a control is kept up thereby. When the sleepers are found to take up a greater average quantity of solution, the strength of the solution is lessened, and *vice versâ*, so that the quantity of sulphate of copper in each sleeper should be as much as possible a constant one. The overseer, a Hungarian, does this quite mechanically. Inspector Eichinger, at Vienna, told me that while natural beech sleepers last scarcely three years, the impregnated ones with the above process last as long as oak sleepers. He belongs to the K. K. Südbahn Gesellschaft, head-quarters, Vienna, and kindly offered to give any further information which may be desired.

At Brannenburg, in Bavaria, between Innsbruck and Rosenheim, I saw the sawmills of Messrs. Heinbeis & Co. They had tanks there which had formerly been used for kyanizing *P. sylvestris* railway sleepers. There was also a store of beech sleepers at the works which had been impregnated according to

Boucherie's process. I do not know if the method had been applied successfully. The sleepers had been lying there eight years, and different kinds of fungi were growing upon them. The line of railway which passes Brannenberg uses kyanized *P. sylvestris* and larch sleepers. When I met Mr. Heinbeis afterwards at Munich, he spoke to me about the difficulties which are encountered with the Boucherie process. Branch-roots and mechanical injuries cause interruptions of the impregnation. The flow of the impregnating liquid ceases throughout all those longitudinal sap vessels which lie in the direction beyond. Branch-roots form obstacles, through and round which the sap flows with difficulty, and in the case of mechanical injuries the sap exudes, and it is difficult by stuffing the holes to make it re-enter the interrupted sap vessels. The imperfect impregnation of a part of a log is likely to render the whole impregnation useless.

At Kirchseeon, between Munich and Rosenheim, is a large impregnation work, belonging to the Bavarian State Railways. I visited this work. There is a very large store of sleepers of *P. sylvestris* and *P. picea* deliberately mixed. Two methods of impregnation are in use—kyanizing and the pneumatic process. For the kyanizing process a shed of 200 feet length and 40 feet breadth was erected. Along both sides are the wooden tanks, and in the middle line runs a railway. This railway has the same gauge as the big line, and a network of the same gauge covers the yard for collecting and storing the sleepers. The bottom of the railway waggons was at a level with the middle depth of the tanks. During the time of my visit some tanks were empty, some filled with sleepers without the liquid, and in some the sleepers were covered with the liquid. They were kept down by means of crosspieces. The overseer denied that the operation was very dangerous. A death of a workman, which had lately occurred, had been falsely attributed to the poison. He says the men enjoyed very much the preventives which were formerly issued to them in the shape of sugar and eggs. On some of the kyanized sleepers I saw a few small sponges growing. The pneumatic apparatus consists of one cylinder, of sufficient length to charge it with four frame

waggons of sleepers. A special engine works the pumps by preference to their being connected with a sawmill engine, which is also on the premises. The frame waggons run direct upon rails of a narrow gauge. These rails are extended over the yard to a short distance. When sleepers are to be shifted to or from greater distances, they are reloaded from the small frame waggons on the narrow gauge to the big waggons on the broad gauge. Hitherto the impregnating material had been tar oil, but a few days before my visit a change had been made, chloride of zinc being now used. No alteration in the apparatus was necessary for this purpose. Only a change in the manipulation took place, in so far as the former process of drying the sleepers artificially was given up, and the plan of steaming was adopted. Formerly the drying took place in a stove immediately opposite the cylinder. The sleepers were placed into the stove on the frame waggon, and could be pushed at once from the stove into the cylinder. The stove was heated by means of steam pipes. The pressure with which the solution of chloride of zinc is forced into the cylinder is 112lbs. per square inch. Whilst I was there it rose once to 140lbs., but this was by accident. The strength of the solution is the same as at Hanover. They will charge the cylinder twice a day now; whilst formerly, with tar oil, and when they had not to steam the sleepers, they charged three times a day.

Not less than three methods have thus been in use at this one place. Beyond doubt, none of these methods has yet entirely superseded the others. Whilst zinc was here used instead of tar oil, I heard at the same time of tar oil having been used anew at another place in Bavaria. It must be allowed that the fluctuations in the prices of the impregnating material have at least as much to do with those changes as the difference of opinion regarding their efficacy.

I inquired about Boucherie's process, and was told that the Bavarian Ostbahn, which formerly made use of it, had now given it up. The works had been near the Ost Bahnhof. When I went to the railway station, near Munich, I could not obtain any information regarding the remaining plant from Boucherie's process. I found, however, that soaking of sleepers in subli-

mate was carried out close to the station by a private firm. This firm supplied mixed *P. sylvestris* and *P. picea* sleepers to the State railways of Wurttemberg, and kyanized them according to the contract. The tanks were as usual of wood, with waxed joints. They had primitive arrangements for preparing the solution. A small boiler was there for heating the water with, and wooden buckets for mixing the powder with the hot water. The workman in charge, who did all this work, seemed not to have suffered from the poison. He showed me that his teeth were slightly affected. He was so careless that, when taking a sample of liquor out of the tank in which the sleepers were being soaked, he dipped the whole hand into the fluid, and did not wash afterwards. He showed me how he tested the fluid by means of a graduated tube and a solution of iodide of potassium. He added so much of the iodide that a precipitate was not only formed but just redissolved. This plan is very simple and a good substitute for the specific gravity test. He also assured me that the solution of sublimate becomes weaker through the immersion of the wood. This fact would indicate a real absorbing power and affinity of the wood to the sublimate itself, not a taking up of the fluid only.

At Strassburg, I went to see M. Bemmelmanns, Betriebs-Inspector of the Imperial railways of Elsass-Lothringen. He told me that, for the Imperial railways in Elsass-Lothringen, they impregnate sleepers with tar oil by the pneumatic process. Mr. André, who is mentioned in Hensinger's book as a timber merchant and impregnator of timber, died in 1874. He used at one time to impregnate timber according to Boucherie's method, but the work was discontinued. As far as Mr. Bemmelmanns knew, the French railways have also discontinued Boucherie's process, and have introduced in its place the pneumatic process with sulphate of copper. They have a custom of adding to each charge one sleeper of double length. This sleeper is afterwards sawn in two, and thus an opportunity afforded for examining it. The principal obstacle in the way of Boucherie's method is, in Mr. Bemmelmanns' opinion, the necessity of impregnating the beams all in a fresh state.

At the railway station of Biberach Zell, in Baden, on the

Baden Black Forest Railway, are impregnation works, which belong to Mr. J. Oesterreicher, of Deutz-on-the-Rhine.

Telegraph posts of *Pinus abies* and *Pinus picea*, 30 feet long, are here impregnated, according to Boucherie's process, with a solution of copper vitriol of one per cent. strength.

When I was present the number of logs which were being operated upon was about 400. They were lying parallel in long rows, the thick ends were raised a few feet higher than the thin top ends. The impregnation takes place at the thick ends. Along these the pipes are conveyed which contain the copper solution. A kind of trough is also attached, by which wasted solution is collected. At each stem a small india-rubber feeding pipe is attached to the horizontal pipe. The box at the face of the stem is formed in the following way. A hemp ropering is laid upon the flat sawn face close to the periphery, and upon this a round plate of hard wood. Outside of this plate comes a crosspiece of hard wood, which projects on both sides beyond the plate. Two screw bolts are passed through the crosspiece close to the ends. These bolts are two feet long. Their sharpened ends are bent at a right angle, and forced into the stem. A hold being thus obtained, the crosspiece may be approached to the face of the stem by turning the nuts, which are fitted to the screw bolts at the outer side of the crosspiece. By approaching the crosspiece to the face of the stem the plate is also pressed in the same direction, and the ropering is caused to form a tight enclosure between the face of the stem and the plate. The above-mentioned india-rubber feeding pipe leads the impregnating liquid through an opening of the plate into the enclosure. When the pressure is exerted from the reservoirs, which stand 20 to 35 feet higher, the liquid commences to enter the wood, whilst sap issues at the thin end. It was a matter of special interest for me to observe at what rate the sap issued at the thin end. It is well known that the speed with which the sap is expelled depends upon the kind and the growth of the tree, and varies very much. I found that the sap issued at the rate of from one drop in every two seconds to one drop in every half second. The complete impregnation may last from four to ten days. Much fluid was lost at the thick

end of the stems, but it was collected again as already mentioned. Some trees lost also fluid at various points of the stem where the bark was injured. The amount of fluid thus lost was with some trees equal to the amount which dropped from the thin ends. The thin ends of the trees were at the fresh cut covered by a layer of resin, which must have issued slowly with the sap. The fluid passes through the sap wood only, and not through the heart wood. Through the kindness of Mr. Oesterreicher, I am enabled to submit samples. They are six discs sawn from the thick end, the middle, and the thin end of an impregnated and unimpregnated log. Mr. Oesterreicher produced a red colour on the surface of the impregnated samples by bringing ferrocyanide of potash into contact with the sulphate of copper in the wood. Whilst a considerable portion of the disc from the thick ends remains unimpregnated, the disc from the thin end is impregnated to the centre. I tasted the fluid which dropped from the thin ends of the stems. Whilst in some cases the fluid was quite tasteless, it was in others strongly charged with sulphate of copper. Always it was remarkably clear. The fluid which issued from the thin ends of the stems was all permitted to run to waste. When the stems were sufficiently impregnated they were taken off. A disc has to be sawn off at the thick end because the face becomes soiled by the solution, After this the bark has to be peeled off. Mr. Oesterreicher tells me that the German Imperial Telegraph Administration in Berlin has adopted this process, and that the telegraph administration in Paris is in possession of Boucherie's patent.

2. *Résume of the General Results.*

In the year 1868 a conference was held of Engineers of the German railways. The impregnation of sleepers was one of the subjects discussed at this conference. Not less than forty railway administrations laid before the conference the results of their experience with impregnated and unimpregnated sleepers.

It is from these communications that the late writers on the subject in Germany have derived most material. Heusinger's "Handbuch fur specielle Eisenbahnkunde" contains a long

chapter on impregnation, with tabular statements based upon the communications of the conference of 1868. In the tabular statement about the duration of sleepers the different methods of impregnation are all classed together, so that only a general comparison between natural and impregnated sleepers is possible.

In order to ascertain the relative value of different processes and substances, it is necessary to give the result of each separately. For this purpose I have compiled from the original reports a new tabular statement, which shows the effect of *different substances and methods upon four kinds of wood.* I have also added the strength of the solutions, &c., and the very approximative cost of the materials and the processes.

The correctness of many reports about the duration of sleepers has been doubted. The observations have to last for many years, *and are rarely completed by the same engineer. Further,* a great many circumstances which have nothing to do with the impregnation can tend to produce quite contrary results. Such difficulties will always exist in a more or less degree, and on their account we must not undervalue the reports of the conference of 1868. *They are the result of inquiries on the* largest possible scale carried on by the most competent persons. The reports are printed in full in the Supplement III. to the "Organ fur die Fortschritte des Eisenbahnwesens," 1869. I have obtained this volume at Vienna, and despatch it with the other books and samples.

In compiling the new tabular statement I have not been exclusively guided by the reports of the conference of 1868; but I have also paid regard to such other information as I could with certainty rely upon; for instance, the excellent Braunschweig experiments. I have left out the process of mere soaking with sulphate of copper and chloride of zinc. The results are so far encouraging, but inferior to those obtained with more perfect methods of impregnation. To ascertain the preserving power of the different substances it is best to select only those experiments in which the impregnation is complete. In itself soaking is not to be condemned. If it is only continued long enough, the impregnation must be just as perfect as with the

pneumatic method. With the increased duration of the soaking the amount of plant may, however, become so great that the pneumatic method will be far the cheaper in the end, supposing, of course, that the number of sleepers will be sufficient to occupy the pneumatic apparatus fully.

When sublimate is the substance, soaking is considered as a sufficiently complete manipulation, because the sublimate acts in small quantities which can readily be absorbed. I have included the results of Boucherie's process in the statement. They happen to be less favourable than the pneumatic processes and kyanizing, but the number of examples was small. Boucherie's process is more in favour for telegraph rods than for railway sleepers. The necessity of impregnating the timber in a fresh state must interfere in many cases with the supply of large quantities. The pneumatic process with sulphate of copper is, for this reason, more applicable than Boucherie's, whenever the number of sleepers is large enough to compensate for the high price of the copper cylinder.

The most important processes at present in favour for railway sleepers on the Continent are, thus, the pneumatic processes with tar oil, chloride of zinc, and sulphate of copper, and the kyanizing process, Boucherie's process being more used for telegraph rods than for sleepers. Of the above four processes, the one with tar oil is the very best, the other three are pretty equal to each other and slightly inferior to the first. The choice between the four methods depends to a great extent upon the fluctuations in the price of the impregnating material.

The pneumatic process with chloride of zinc recommends itself most for an experiment with hitherto untried kinds of timber in a foreign climate. I would, however, be very anxious also to see another substance tried on a comparatively smaller scale, namely, the sulphate of zinc. I am of the opinion that this salt may have advantages over both the sulphate of copper and the chloride of zinc. I have found that it is not, as I formerly supposed, dearer than chloride of zinc, but it is at present cheaper. Sulphate of zinc would be very well suited for transport. The chloride of zinc, which is usually obtained in solution, might also be solidified by evaporation, but still it

remains a highly hygroscopic, and therefore somewhat inconvenient, substance. I have not been able to obtain the result of any experiments with sulphate of zinc. I only found it mentioned once as applied jointly with sulphate of iron for soaking sleepers.

It remains to draw attention to the tabular statement now following, which embodies the result of the whole inquiry.

Statement of the Comparative Result, Cost, &c., of various Methods of Impregnation, according to the Reports in 1868 *by the German (including Austrian) Railways and according to other information obtained in Germany in November* 1876 *by* Dr. H. Warth.

Kind of Timber.	1. Natural State.	2. Pneumatic Process. Creosote.	3. Pneumatic Process. Chloride of Zinc.	4. Pneumatic Process. Copper Vitriol.	5. Boucherie's Process. Copper Vitriol.	6. Soaking Sublimate.
Average age of sleepers in years :						
Quercus, oak... ...	13	20	19	...	...	15
Fagus sylvatica, beech ...	3	19	15	12	8	14
Pinus sylvestris ...	7	...	17	16	14	15
Pinus picea	4	...	...	...	...	14
Average quantities and prices :						
Strength of solution in percentage.	...	...	2 per cent (25 per cent. zinc.)	2 per cent	1 per cent.	0 66 per cent.
Quantity taken up by 1 cubic foot of wood ... oak ...	...	3 lbs.	·2 lbs.	...	...	0·066 lbs.
beech and pines.	...	10 lbs.	·5 lbs.	·3 lbs.	·3 lbs.	0·066 lbs.
Price of the materials in £ per ton.	...	3*l.*	10l. (solution with 25 per cent zinc)	30*l.*	30*l.*	350*l.*
Cost of the materials per cubic foot in pence - oak...	...	1*s.*	2*d.*	...	...	2*s.* 5*d.*
beech and pines.	...	3*s.* 2*d.*	5*d.*	1*s.*	1*s.*	2*s.* 5*d.*
Cost of the processes approximatively alone without the material.	...	1*s.*	1*s.*	1*s.*	1*s.*	5*d.*
Total cost of the whole process including the price of the material.	...	Oak, 2*s.* Beech and Pines 4*s.* 2*d.*	1*s.* 2*d* 1*s.* 5*d.*	2*s.*	2*s.*	2*s.* 10*d.*

3. *Answers to the Questions which Dr. Brandis put to me.*

The foregoing contains already the answer to the questions which Dr. Brandis, the Inspector-General of Forests, East India, has put to me respecting the impregnation of sleepers on the Continent. I would say as follows:—

1*st Question.*—What is the result of the experiments up

to date with regard to chloride of zinc; and are the apparatus used for that substance the same as those employed for creosote? (Braunschweig and Hanover.)

Answer.—The result of the pneumatic process with chloride of zinc is almost equal to that of the pneumatic creosoting, the duration of the oak, beech, and *Pinus sylvestris* sleepers being protracted from respectively 13, 3, and 7 years to 19, 15, and 17 years. The apparatus used for the pneumatic process with chloride of zinc are the same as those used for creosoting, so much so that a change from the one material to the other can be effected without alteration of the apparatus.

2nd Question.—Is corrosive sublimate still used, and how is it employed? Strength of solution, temperature, immersion, or how? What has been the result of the process on different kinds of timber?

Answer.—Yes, it is still used. It is applied by soaking the sleepers up to a fortnight in a solution of 0·66 per cent. of sublimate. I have not seen arrangements for warming the solution. The following kinds of timber,—oak, beech, *Pinus sylvestris*, and *Pinus picea*, with a natural durability of respectively 13, 3, 7, and 4 years, have attained a durability of 15, 14, 15 and 14 years.

3rd Question.—Sulphate of copper is used in Austria under Boucherie's process. What is the experience regarding durability of sleepers thus impregnated?

Answer.—This method appears at present little in use for sleepers. I only met with one experiment in Bavaria, where beech sleepers had been impregnated. The method is, however, greatly in favour for telegraph posts.

The few records which I obtained about the durability of sleepers impregnated under this process are not quite so favourable as those of other processes. Beech and *Pinus sylvestris* sleepers had their durability extended from 3 and 7 years respectively to 8 and 14 years.

4th Question.—Sulphate of copper is used under the pneumatic process in the Lombardy (Alta-Italia) railways. What is the experience regarding durability of sleepers, and what apparatus is used?

Answer.—I have seen the process at Salloch, near Laibach, in Krain, in Austria. The engineer of the K. K. Südbahn, at Vienna, told me that Salloch used to supply the Alta-Italia railway with impregnated sleepers. The durability of beech and *Pinus sylvestris* sleepers is raised by this process according to the above statement from respectively 3 and 7 years to 12 and 16 years. Mr. Eichinger, the engineer of the K. K. Südbahn, says that, according to his experience, beech sleepers, which are impregnated at Salloch, last as long as oak sleepers, whilst they would deteriorate in three years if left in their natural state. The apparatus is the same as the one used for pneumatic impregnation with other substances, except that the impregnating cylinder is of copper instead of iron, though strengthened by iron rings. Iron is also avoided in the construction of the pumps for the copper solution, and of the frame waggons. The latter are built of wood and bronze only. The tubes which convey the fluid are of copper. The high price of the copper cylinder is amply compensated by the rapidity of the process.

H. WARTH,
Collector, Inland Customs, Punjab Mines Div., on furlough.

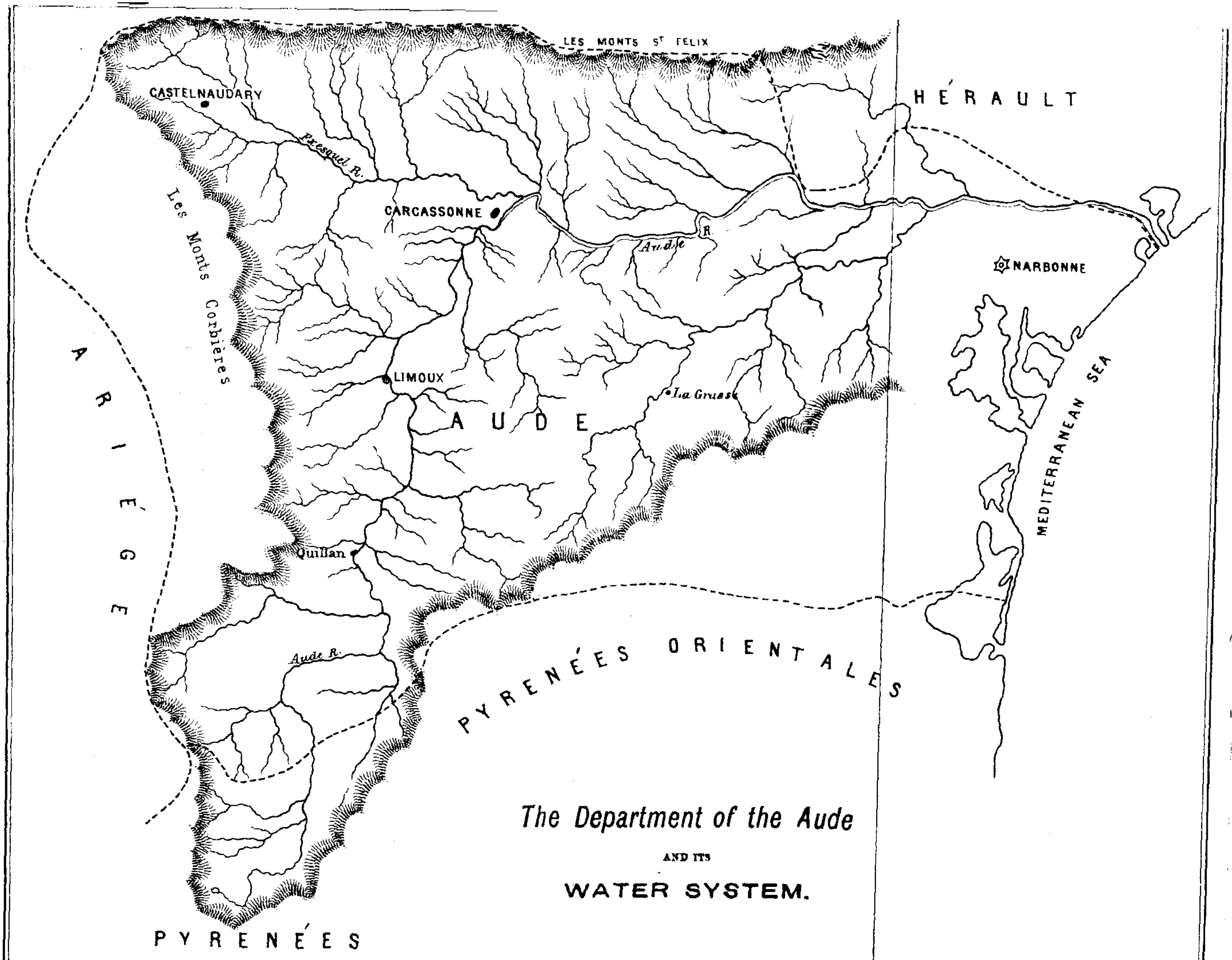
The management of the Water System in the Department of the Aude, by M. Rousseau, originally published in the 'Atlas Météorologique de l' Observatoire de Paris,' translated from the 'Revue des Eaux et Forêts,' July 1877.

While engaged in drawing up a careful statistical account of the effect of the great inundations which caused such disasters in the south of France in June 1875, I was led to make an enquiry into their origin and causes. As I have been long attached to the Department of the Aude, I have been able to make use, not only of the information I obtained at the time, but also of what I have accumulated during many years, and of the official documents relating to the losses sustained by the inhabitants of the Department. The principles

upon which I have based the present article are those which were used by M. Belgrand in his great work on the Seine, and I have completed them by an exact statistical account of the area under cultivation, waste or forest in the basin of the Aude.

I have very carefully classified the geological formation as *permeable* and *impermeable*. As the geological map of the department is not yet published, there was considerable difficulty in doing this correctly ; but my own map, prepared during 15 years of continual travel over the department, seems to me amply sufficient for a general classification, and especially for the separation of the different formations into *permeable* and *impermeable*. When the varied elements at my disposal, and the special observations I had made in numerous valleys, after the great rains of June 21st to 23rd, 1875, had been properly arranged, I was able to give the following general results : The Aude is neither a big river nor yet a stream ; it can only be called a torrent. It rises at an elevation of 2,130 mètres (6,988 feet), and its length is only 227 kilomètres (141 miles), so that its average fall is only 938 millimètres in 100 mètres (1 in 106·5 feet). But this average slope represents nothing, and is in reality the rock on which so many persons with theories on the subject of inundations have split.

The basin of a river which takes its source in lofty mountains comprises two distinct regions ; *first*, the *catchment basin* which is within the mountains and with a considerable average slope ; and, *secondly*, the *basin of outflow* which is chiefly on low land and with very slight difference of level. In the case of the Aude this distinction is fully justified : its mountain region, however, comprises several zones in which the soil and the fall of the river vary considerably. Thus in the high mountain section from the source of the river in the E. Pyrenees to Quillan the distance traversed by the river is 80 kilomètres (50 miles) and the fall 1,850 mètres (6,070 feet), or an average of 23 millimètres in the mètre (1 in 43). The middle section, part hill and part level ground, lies between Quillan and Carcassonne, the distance is 54 kilomètres (33½ miles), and the average fall 3 millimètres in the mètre (1 in 333). From



The Department of the Aude

AND ITS

WATER SYSTEM.

Carcassonne to the sea, the true zone of inundation, the distance is 93 kilomètres (59 miles), and the average fall 1 millimètre in the mètre (1 in 1,000) ; but in spite of this very slight change of level, the Aude at Carcassonne in seasons of inundation when the water rises 4-6 mètres (13 to 19 feet) has often a velocity of 18 kilomètres (11 miles) per hour.

During its course, numerous affluents pour their waters into the Aude ; like it, they nearly all have their own basins of catchment and outflow ; and all protective measures which may be undertaken with a view to regularize the flow of water in the principal stream, must necessarily be applied to the whole water system, if any good result is to be produced.

The total area of the Aude basin consists of 460,864 hectares, of which only part are in the department of that name, the rest being divided as follows: Herault, 18,000, Ariège 14,000, and the E. Pyrenees 22,500 hectares. The whole area of the departments of the Aude consists of 405,364 hectares, of which, as we have seen, the Aude basin only forms a part ; the remainder lies partly in those of the Garonne Tarn and Gly, and partly in the country watered by small streams which flow either directly into the sea or into the salt lakes which border its shores.

The distribution of land in the basin of the Aude may be set down as—

	Hectare.
1.—Cultivated land, including vineyards, gardens, towns and villages, roads, lakes and streams	260,311
2.—Unculturable land	139,358
3.—Forests and shrubby growth ...	54,557
4.—Grass lands more or less irrigable ...	6,144
	460,370

Thus it will be seen that most of the area consists of land which is impermeable or incapable of absorbing a heavy rainfall, when such a rainfull occurs ; all that falls on land of the first two categories is drawn off in water courses (thalwy) with the

greatest rapidity, and this rapidity is further increased to the greatest possible extent by opening on every hand ditches capable of carrying off at once the rainwater which falls on the fields and vineyards; there consequently only remains about 60,000 hectares of wooded and meadow land, on which infiltration can slowly take place, and contribute to diminish the intensity of floods. Now the influence which the growth on such land exerts is so much less from its being already established on permeable soil, and it is consequently so necessary in order to increase the amount of water which can be absorbed, to create an absorbing surface in places where it does not already exist; and this can only be done by artificially reclaiming for forest or pasture the unculturable land—land which every day is losing more and more of its elements of fertility and becoming sterile and resistant to the infiltration of rain water.

When we consider that most of the unculturable land in the mountain zone lies on slopes often exceedingly steep, the cause of the overflow of water is easily determined. On these slopes water runs, or rather rolls, down with violence, carrying with it always stones and mineral matter of all sizes and description, and the case is still further aggravated by the impermeable nature of the soil. In fact, on the whole area of 460,000 hectares, we can only count 16,000 as wholly or in part permeable; the rest is composed of different varieties of rocks, such as granite, Devonian schists, and limestone bœccia and limestone supposed to be carboniferous, Garonne marls, limestone and conglomerates, nummerletic marls and limestone and Circassian conglomeratė marls, clay slates and sandstones—all of them incapable of easy penetration by water. Of the different formations here enumerated those which are poorest, most denuded, and most deeply ravined are the layers of marl and clay, and it is precisely these layers which are the most dangerous, because in them no cultivation is capable of producing a spongy layer suitable for retaining a portion of the surface water.

On the 21st June 1875, after an almost uninterrupted drought of 51 days, the basin of the Aude was visited by heavy

rains from the west. These rains began at 12-45 on the 21st, and did not cease till 4-15 on the evening of the 23rd instant, thus having fallen for 52 hours almost consecutively.

The details of the rainfall were speedily sent from the 25 stations of measurement, and from these details it appeared that the greatest fall occurred at Arques, in the village of Corbiéres, in the valley of the Rialsesse, in the centre of the Garonne marls and conglomerates, where 240·5 M. M. (9½ in.) fell. The lowest rainfall was at Narbonne, whence only 56·5 M. M. (2¼in.) were reported. Between these extremes, and choosing stations almost equidistant and distributed regularly over the basin, I have deduced an approximate average of 150 M. M. (nearly 6 in.) for the whole basin of the Aude. If, therefore, we consider 150 M. M. to have fallen uniformly over the whole area, we find that the total volume of the sheet of water which fell during the 52 hours in the basin of the Aude amounted to 691 millions of cubic metres which flowed off very quickly, as much in consequence of the steep slope of the land as of the denuded and impermeable nature of the soil. The whole of it, however, did not pass Carcassonne, since between that town and the sea the Aude receives numerous affluents; but, at any rate, a large portion did pass that town, since, when the inundation was at its highest, *viz.*, 5·40 metres, at 11 o'clock on the morning of the 23rd the velocity of the river being 18 kilometres per hour, the volume of water which passed amounted to 3,375 cubic metres per second. The maximum was only kept up for 40 minutes, during which time 8,100,000 cubic metres of heavy turgid water passed, carrying with it not only mud and sand, but gravel and even boulders.

I calculated from hourly observations that, during the 23rd June, from 5 in the morning to 8 at night, 150 millions of cubic metres passed in this manner; and the previous day 80 millions had passed, so that out of 340 millions of cubic metres of water which had fallen in the basin of the Aude above Carcassonne, 270 millions had been brought down in two days and had caused an inundation; while of the remaining 70 millions, part had flowed off after the 23rd as the water subsided, and part had been absorbed by the soil which had been on the 21st

exceptionally dried up. But the quantity thus absorbed was very small, and 25 to 30 millions of cubic metres were sufficient to saturate the impermeable lands, and this must have taken place during the first day of rain. The remainder, which could neither penetrate the soil nor remain by itself on slipping slopes, must have found its way quickly into the mountain streams; and, as all these streams were acting at the same time, and as the Aude has so many affluents, the result was that everywhere the rivers overflowed, and inundations were produced, which caused serious damage to the extent of at least 3,409,000 francs.

These catastrophes are so often renewed that urgent measures must be taken to diminish their effects. The June floods were followed by others in September—floods which, though not absolutely so great, were more disastrous, since they destroyed vine crops to the extent of 8,000,000 francs. They were preceded in August 1872 by an inundation which caused a loss of 2,000,000 francs to the proprietors of land bordering on the river; and by another in September 1874, the damage done by which amounted to 2,260,000 francs.

The department has thus, since 1872 only, lost 15,669,000 francs alone in consequence of four different floods.

The only method of counteracting this scourge of the country is the *reboisement* of the 140,000 hectares of uncultivated land situated on impermeable formations, and the construction of dams, weirs and other works of consolidation.

These *reboisements* should, whenever possible, be only made with persistent-leaved conifers or evergreen oaks, because these species, always provided with leaves, arrest the flow of the rain water during the whole year, facilitate its partial evaporation before reaching the ground, and cover the soil with a thick layer of *humus*, capable, in consequence of its exceedingly permeable surface, of retaining a very large proportion of the rain which falls on it.

In fact, from the experiments which I have been making during the last 3 years, the result has been that, under the cover of evergreen oaks, only slightly more than half the rain which falls upon the leaves ever reaches the ground, and this is proved

by the comparison of my rain guages, which, during 1875, gave the following results:—

	Outside the forest. Millimetres		in.	*Inside the forest.* Millimetres.		in.
In Winter ...	179·3	Equal to	7·06	55·1	Equal to	2·17
„ Spring ...	162·7	„	6·40	84·4	„	3·32
„ Summer ...	303·3	„	11·94	169·8	„	6·68
„ Autumn ...	323·1	„	12·72	162·1	„	6·38
Yearly Total ...	968·4	„	38·12	471·4	„	18·55

During the great rains of the 21st to 24th June the results were much less conclusive; outside the forest 162·2 M. M. were collected, while inside only 108 M. M. were registered. The change of proportion is, however, easily explained, since the rain on those days fell continuously, and the leaves, once saturated, no longer broke the fall of the drops of rain. Besides, the atmosphere itself was then saturated to the highest point, and evaporation less active in consequence of the low temperature. Nevertheless, in spite of these unfavorable conditions, the evergreen forest vegetation prevented 35 per cent. of the rain from reaching the ground, and these 35 per cent., having thus been completely lost, was prevented from contributing to swell the mass of water which formed the inundation.

The deductions which can be made from these calculations are, that, had the *reboisement* of the 140,000 hectares of unculturable land in the basin of the Aude been made, the heavy rainfall of June 1875 would have been reduced from 150 M. M. *to* 95½, *the volume of water brought down would have* been decreased from 631 to 410 millions of cubic metres, the flood level would have fallen from 5·4 M. to 3·6 metres, and no disastrous inundation would have taken place.

The expenditure necessary for these works would amount to 16,000,000 francs, which, independently of their good investment as a preventive measure, would yield in time a considerable revenue, while all the other means of protection against floods are not only unproductive, but also threaten a dreadful catastrophe should the dykes or dams happen to break as they did in so many places in 1875.

List of Wild Plants and Vegetables used as Food by People in Famine Times.

From Surgeon-Major J. SHORTT, M.D., *Inspector of Vaccination, Madras Presidency, to the Sanitary Commissioner of Madras, dated 3rd May* 1877, *No.* 263.

I have the honor to submit a list of most of the wild plants, their roots, leaves, fruits or seeds that are eaten by the poor during seasons of drought and famine. I give both the Scientific, Tamil and Telugu names in the list, believing that it may prove of interest just now.

2. I commenced the collection first during a visit to Ganjam in 1870, and have to thank G. H. Ellis, Esq., and J. G. Thompson, Esq., the then Collector and Judge of that district, who kindly, at my request, procured for me several specimens for identification. Since that I have been adding to the number, and during a tour to the Bellary, Kurnool, and Cuddapah districts in December 1876, at the onset of the present famine, and in the North-Arcot and Salem districts during 1877, I collected further information.

3. The list is alphabetically arranged; many of the leaves and young shoots of those used as greens are much more frequently used as *Calavay Keeray* or mixed greens. This is a favorite mode of using them at all seasons, and they are in great repute even among well-to-do people. Women collect the wild greens both as an amusement and occupation, adding at the same time an additional dish to the family meal. Many European and East Indian families are partial to them, as they are said to be healthy and to have a slight laxative action on the bowels; and they will frequently send their female servants out to collect them.

4. The tender pith and leaf-bud of the Hedge Aloe is only eaten by the poor from great pressure of hunger, as it is unwholesome and causes dysentery and diarrhœa.

5. Some of the Arum tribe that are used on these occasions are not only unwholesome but poisonous; to avoid their deleterious effects they are repeatedly boiled ere eating. The various fruits are eaten ripe as they come into season. The

Banian, Peepul, and Country Fig furnish food not only to the poor people but to cattle also. The kernel of the mango and the tamarind stone are converted into meal and cooked into porridge, or baked into cakes, but as they contain a large proportion of tannin, they are not healthy, and are only resorted to during seasons of scarcity. The bamboo seed furnishes a kind of rice, which is generally collected by the poor during the season at all times to keep them in food. In most jungles there is always a succession of bamboo in seed every year. The fruit of the prickly-pear is eaten ripe; sometimes the green fruits are boiled. The tender leaves would furnish good vegetable for curry, but is not often resorted to as the prickly-pear possesses sub-acid or anti-scorbutic properties; it is very beneficial to the health both of man and beast. To Mr. H. S. Thomas, the Collector of Tanjore, the credit is due of first suggesting and subsequently demonstrating practically its value as cattle fodder by feeding his own cattle on it and exhibiting the same in public, thus proving its utility, and it has been introduced to public notice by Messrs. Harvey and Sabapathy, of Bellary, since. It has not met with general acceptance in consequence of the trouble and difficulty of freeing the leaves of their sharp spines, but there is a spineless variety—*Opuntia delenii*, or Nopaul with red flowers—which is met with about Madras. I remember seeing lots of it growing about the village of Karanguli, in the District of Chingleput, some years ago. It would be worth while introducing this Cactus into the several districts to form cattle fodder, not only during seasons of scarcity, but at all other times.

NOTE.—This variety of *Opuntia* was introduced many years ago by the late Dr. James Anderson to feed the cochineal insect. Dr. Anderson used to supply Her Majesty's ships-of-war in the Madras roads with the green leaves, which in those days were used as an anti-scorbutic, after being boiled as an ordinary green vegetable. W. R. C.

The *Guazuma tomentosa*, or Bastard Cedar, was introduced into Southern India from South America very many years ago, to be cultivated for supplying cattle with fodder; they are met with about Madras. The woody seeds are sweet from containing sugar, and they are eaten by the poor during seasons of scarcity, but cattle are partial to both leaves and

fruits. This tree also yields good fibre, and its extensive cultivation into the several districts is well worthy of attention with a view to supply fodder for cattle during seasons of scarcity. The Bassia, of which there are two varieties, from the fleshy corolla of which most of the semi-wild tribes distil their *arrack*, the flowers being sweet-tasted are eaten raw, boiled or roasted, and the ripe fruits during the season. The kernels furnish a coarse oil, which is used as food. The palmyra tree is too well known for the various useful products it furnishes. The fusiform root of the germinating stone is boiled and sold in the bazaars during the season as the palmyra tubers or *Pannei Kulungu*. This is also converted into meal, and the stones of the fruit are carefully collected and put down to germinate for the purpose of securing the roots.

I will not extend these remarks further as the parts used and the mode in which they are prepared are given opposite each plant.

NOTE.—Since this letter was written I have been to the North Arcot District on a tour of inspection, and at the village of Poloor in that district saw several large clumps of the Nopaul or Nonspinous Cactus growing in a tope. The Tahsildar being absent, I sent for the Sheristadar or Sub-Magistrate, and pointed out the Nopaul to him. I brought with me several specimens of the young plant; and, on receiving a note from Mr. Fernandez of the Government Office on the subject, I sent these plants to him to present to the Chief Secretary to Government.

At Vellore near the toll-gate, leading towards the Central Jail, I also saw several young plants of the Nopaul growing in a hedge with the common spinous cactus.

In Madras there is a fine specimen of the Nopaul to be seen in a House No. 31, on the High Road, Royapooram, and another in the compound of Trinity Chapel, John Pareira's; both these plants were with flower and fruit when seen by me about two months ago.

A List of Plants, the various parts of which are used as Food by the Poor, during seasons of Distress, to appease the cravings of Hunger.

Scientific Names.	Tamil Names.	Telugu Names.	Remarks.
1. Acalypha Indica	Koopay maynei ...	Harita munjari ...	Grows wild; leaves used as greens.
2. Achyranthes aspera.	Nahi ooroovie keeray	Ooteraynie ...	Do. do. do.
3. Arua lœnata ...	Kunpolay keeray ...	Pindie conda ...	Grows wild, and cultivated; the leaves eaten.
4. Agati grandiflora	Aghati keeray ...	Agisi, Bakapushpam	Leaves, flowers, and tender legumes largely consumed by the poor; sold in the bazaars at one pie the pound; when freely eaten, causes diarrhœa.
5. Æschynomene aspera.	Sudday keeray ...	Jilugu benda ...	Grows wild; the leaflets used as greens.
6. Aloe vulgaris ...	Kuthalay ...	Kalabanda ...	Grows wild, the leaf-bud or cabbage and tender pith eaten. The common food of villagers during the famine.
7. Altenanthera sessilis	Poonanghucunny keeray.	Madanaganit, Ponn-aganti.	Grows wild, leaves used as greens.
8. Amaranthus campestris.	Siru keeray ...	Teseri kura ...	Grows wild, and cultivated; used as greens.
9. ,, frumentaceous.	Poong keeray ...	Tola kura ...	Grows wild, and cultivated; leaves used as greens, and the seeds converted into meal.
10. ,, spinosus ...	Mooloo keeray ...	Mulugoranta ...	Grows wild; leaves eaten as greens.
11. ,, tenuifolius	Katto Siroo keeray ...	Doggali kura ...	Grows wild; used as greens.
12. ,, tristis ...	Kuppei keeray ...	Koyyatota kura ...	Do. do. do
13. Amorphophallus campanulatus.	Kurruna kalungu ...	Konda, muncha kunda.	Do. about hills and forests, and the tubers boiled and eaten.
14. Aponogeton monostachyon.	Kotee kalungu ...	Nama ...	Grows wild; found in tanks, brooks and nullahs; tubers boiled and eaten.
15. Arum lyratum ...	Kondai rakis ...	Konda rakis ...	The roots are eaten after careful boiling.
16. Asystasia coromandeliana.	Mideby keeray ...	Mukku mungera Tappeta.	Grows wild; used as greens.
17. Atriplex heteranthera	Thoyah keeray ...	Thoya kura ...	Do. do. do.
18. Bambusa arundinacia.	Mungil arisee ...	Veduru ...	Seeds of the bamboo furnish food (rice) to the poor, and the growing young shoots cooked into curries.
19. Bassia longifolia	Elloopei ...	Ippa ...	Grows wild; the deciduous fleshy corolla eaten either raw or roasted, and the fruits when ripe. The seed contains a bland oil used in cooking.
20. ,, latifolia...	Caat elloopei ...	Ippe ...	Do. do. do.
21. Bergera Kœnigii	Karaway pillay ...	Kari vepa ...	Do.; is also cultivated; fruits eaten.
22. Boerhavia procumbens.	Mookaretti keeray ...	Ataka mamidi ...	Grows wild; leaves and tender shoots used as greens.
23. ,, repanda	Mookooty keeray ...	Maidinika ...	Do. do. do.
24. Borassus flabelliformis.	Pannei ...	Karatalamu, Tatichettu.	Fruits and leaf-bud or the cabbage is eaten, as also the fusiform roots.
25. Bryonia rostrata	Appa kovay ...	Putribudinga ...	Grows wild; fruits and leaves eaten.

Scientific Names.	Tamil Names.	Telugu Names.	REMARKS.
26. Byttneria herbacea.	Aree keeray ...	Aree kura ...	Grows wild; leaves used as greens.
27. Calladem esculuntum.	Saimmay keeray ...	Chama kura ...	Grows wild; leaves eaten as greens.
28. Cantheum parvifolia.	Carray cheddie ...	Balusoo kura ...	Grows wild; leaves and young shoots used as greens.
29. Cardiospermum halicacabum.	Moodacottan ...	Budda kankarakoo, or Nella goolisenda.	Do. do. do.
30. Caraluma adsendens.	Kullee mooliayan ...	Karallamu, Taviti chettu.	Do.: tender shoots used; cooked as vegetable.
31. Carissa corindas	Kalakai ...	Wakay okachettu ...	Grows wild; fruits are eaten.
32. " diffusa ...	Chothay kalakai ...	Kalive chettu ...	Do. do. do.
33. Cassia sophera ...	Poonaverie ...	Pydee tanghadu ...	Do; leaves used as greens.
34. Cathartocarpus fistula.	Koonnay ...	Rela ...	Grows wild; the mucilagenous pulp from the pods eaten.
35. Celocia cristata ..	Punnee keeray ...	Erra kodi, Juttu tota kura.	Grows wild; leaves and young shoots used as greens.
36. Ciscus quadrangularis.	Purundei codie ...	Nullerootigeh ...	Do. do. do.
37. Cleome pentaphylla.	Valay keeray ...	Vamınta ...	Do.; leaves used as greens
38. Cocinia Indica ...	Covay kai ...	Donda, Bimbika ...	Grows wild; ripe fruits eaten.
39. Colocasia antiquorum.	Shamaykilangu ...	Chama dumpa ...	Grows wild and cultivated; leaves and leaf stalks eaten.
40. " nymphæfolia	Karoonay kilangu ...	Gadda kanda ...	Grows wild and cultivated; the tubers are cooked.
41. Commelina communis.	Kannang keeray ...	Gangi gadda ...	Grows wild; leaves and tender shoots used as greens.
42. Cordia myxa ...	Vidi maram ...	Iriki, Nakerachettu...	Fruits eaten during the season
43. Corchas olitorius	Kaat theothee, or Jews' Mallow.	Parinta ...	Grows wild; leaves and tender shoots used as greens.
44. Cucmismomordica.	Kaat velleri, Pythum kai.	Pedda doskay ...	Grows wild; fruits eaten.
45. Cynodon dactylon	Aroogum pillo ...	Garike ...	Do.; tender leaves and shoots eaten.
46. Desmantus natans	Sunday keeray ...	Niru talvapu ..	Grows wild; the leaves used as greens.
47. Dioscorea alata...	Yams kalung ...	Niluva pendalum ...	Several varieties grow wild; tubers eaten cooked.
48. Dolichos ensifornis.	Kaat Thumbuten kai	Tamma ...	Grows wild; pods cooked into curries; ripe seeds eaten boiled.
49. Dracontium polyphyllum.	Kaat Curnay ...	Adive kanda ...	Grows wild; tubers eaten cooked.
50. Eleusine Ægyptica.	Muttengapilloo ...	Tamida, Sodee ...	The seed grains are eaten cooked.
51. Eriodendron anfructuosum	Elevam ...	Poor ...	Found in gardens; seeds roasted and eaten.
52. Erythroxylon areolatum.	Davaahdarum keeray	Devadary kura ...	The tender leaves are used as greens; grows wild.
53. Euphorbia pilulifera	Amumpatchay arisee	Bidarie, Nanabecam	Grows wild; leaves and tender shoots eaten as greens.
54. Ficus Bengalensis	Alamarum ...	Marri ...	Fruits of these and ether varieties of the Ficus are eaten ripe.
55. " glomeratta	Attee marum ...	Maydi ...	Do. do do.
56. " religiosa	Arasa marum ...	Ray, Raghie ...	Do. do. do.
57. Glinus triantheni-oides.	Sharunnay keeray ...	Golijeru ...	Wild; leaves used as greens.
58. Gisekia pharnaceoides.	Numnelli keeray ...	Isaka dasari kura ...	Grows wild; the leaves used as greens.
59. Guazuma tomentosum.	Rudrasum ...	Rudrakscha chettu ...	The woody fruits when ripe are eaten.

Scientific Names.	Tamil Names.	Telugu Names.	Remarks.
60. Gynandropsis pentaphylla.	Neivaylla or Kadughoo	Vala kura ...	Grows wild; leaves and young shoots used as greens.
61. Holostemma Rheedi*	Palay keeray ...	Pala kura ...	Leaves boiled with salt and chillies and eaten.
62. Hoya veridiflora	Cooringee keeray ...	....	Grows wild; leaves used as greens.
63. Inga dulcis ...	Coorkapooly ...	*Sima chinta* ...	Ripe fruits eaten.
64. Ipomœa reptans	Vellay keeray ...	Tegada ...	Wild; leaves eaten as greens.
65. ,, reniformis	Perretay do. ...	Toinuatali ...	Do. do. do.
66. ,, sepinaria	Thalee do ...	Puriti tige ...	Do do. do.
67. Leucas aspera ...	Thombay keeray ...	Tummi kura ...	Grows wild, leaves and tender shoots eaten as greens.
68. Maba buxifolia ...	*Erimbellie kai* ...	Pishanna ...	Grows wild; ripe fruits eaten
69. Mangifera Indica	Mankai ...	Mamedi chettu ...	Fruits and seeds; latter converted into meal.
70. Melia azadirachta Indica.	Veypa marum ...	Vapa chettu .	The ripe fruits are eaten, as they contain a small quantity of sweet pulp between stone and skin.
71. Mimusops elengi	Moghadum ...	Poghada	The ripe fruits are eaten.
72. Mirabilis jalapa*	Undi mandarei ...	Badracha, Nitcha mulligah.	The leaves are used as greens largely at Oossoor in the Salem District.
73. Morinda citrifolia	Munja pavattay ...	Molagha, Maddichettu	Grows wild; green fruits *curried, ripe eaten.*
74. ,, umbellata	Noona kai ...	Mooloonghoodoo ...	Grows wild; green fruits curried, ripe eaten
75. Nymphæa edulis	Shunguneer pushpum	Koteka, Kalharamu...	Grows wild in tanks. There are two or three varieties according to the coloring of the flowers. The roots and seeds are eaten cooked.
76. Œgle marmelous	Vilva marum ...	Maredoo ...	Grows wild; the ripe fruits are eaten
77. Opuntia vulgaris	*Chuppauthumoolloo*	*Nagamala* ...	*Grows wild; the ripe* fruits are eaten; the green fruits and tender shoots may be cooked into curries.
78. Oxalis corniculata	Pooliaray ...	Pullachinta ...	Grows wild; leaves and tender shoots cooked as greens.
79. Pandanus odorata	Thalay ...	Mogheli ...	Grows wild; the floral leaves are eaten raw or cooked, and the lower part of the drupes of the ripe fruits are sucked off their pulp.
80. Phaseolus rostratus.	Karalsona ...	Karalasana, Karu alachanda.	Grows wild; the tuberous roots are cooked and eaten.
81. Phœnix sylvestris	Ethum pannay ...	Ita chettu ...	Grows wild; leaf-bud or cabbage and ripe fruits eaten.
82. ,, farinifera	Ethee ...	Chiruta-ita ...	Do. do. do.
83. Portulaca oliracea	Paroopoo or Corie keeray.	Peddapail kura, Ganga pavilli kura.	Grows wild, leaves and tender shoots are *cooked and eaten as* greens.
84. ,, *quadrifida*	*Passelie keeray* ...	*Goddu pavelli, Sun* pail kura.	Do. do. do.
85. Premna serratifolia.	Mooney do. ...	Ghebboon nellie ...	Do. do. do.
86. ,, latifolia	Nella do. ...	Pedda-nella-kura ...	Do. do. do.
87. Prosopsis spicigera.	Parumbay ...	Chamee, or Jammi chettu.	Do. do.; the meals from the pods are eaten.
88. Remna latifolia*	....	Nelli kura ...	These herbs are gathered and boiled with some salt and chillies and eaten.
89. Rivia hypocrater formis.*	Boodthee keeray ...	Boddi kura ...	Do. do. do.
90. Rothia trifolita ...	Nurreypitten keeray	Nucka kura ...	Grows wild; leaves and legumes used as greens.

Scientific Names.	Tamil Names.	Telugu Names.	Remarks.
91. Salicornia bracheata.	Oomarie keeray ...	Queiloo, or Koyaloo	Grows wild; leaves and shoots used as greens.
92. ,, Indica ...	Pavala poondoo ...	Koyya pippali ...	Used as a pot herb.
93. Salsola Indica ...	Yella keeray ...	Yella kura ...	Wild; leaves used as greens, largely resorted to during famines.
94. Schleichera trijuga	Poomarum, Coonjee marum.	May Roa Tanglla ...	Grows wild; ripe fruits are eaten.
95. Schmidelia serrata	Tanalika ...	Tanalikœ korra chettu	Grows wild; fruits are eaten
96. Sesuvium portulacastrum.	Vungaravasee ...	....	The leaves and tender shoots used as a pot herb; grows wild.
97. Sethia Indica ...	Tavadrum, Semmanatty.	Adivi gerenta, Davadary.	Grows wild; leaves and tender shoots eaten as greens. This tree has afforded food to many thousands of people during the famine.
98. Solanun incertum.	Munnuthakalee ...	Kakamachi ...	Grows wild; leaves and young shoots used as greens; ripe fruits eaten.
99. ,, jacquini	Cundung katrie ...	Van kuda, or Nella molunga.	Grows wild; fruits are cooked into curries.
100. ,, torvum	Soonday kai ...	Choondai kai ...	Grows wild; fruits used as vegetable.
101. Spondas mangifera.	Mirrey manga ...	Ambra, or Amra jouru, Mamedi.	Grows wild; leaves used as greens; fruits cooked into curries and pickled.
102. Sterculia fœtida...	Peenaree marum ...	Gurapa Badam chettu	Grows wild; the roasted seeds are eaten
103. Strychnos potatorum.	Tettan cottay marum	Toillaghenjaloo, Indaga.	Grows wild; fruits when ripe are eaten.
104. Suæda Indica ...	Koyey kaseeray keeray.	Kodoo kasseery kura	Used as a pot herb; grows wild.
105. Syzygium jambolanum.	Navel ...	Neradi ...	Grows wild; ripe fruits are eaten.
106. Tamarindus Indica	Poolia marum ...	Chinta chettu ...	Leaves, young shoots, fruits and seeds are eaten; the latter converted into meal
107. Toddalia aculiata	Moolacarnay ...	Conda cashnida ...	Grows wild; leaves are used as greens.
108. Trapa bispinosa	Singahara ...	Kubyakam ...	Grows wild; seeds are cooked and eaten.
109. Trianthema obcordata.	Sharunnay ...	Ghelijehroo ...	Do; leaves and tender shoots used as greens
110. ,, obcordate, Var.	Shavalay keeray ...	Tella gheljieghroo ...	Grows wild; leaves used as greens.
111. Trichianthis cucumera.	Pepoodel ...	Chayud pottah ...	Grows wild; fruits curried.
112. Trilobus terristus	Nerrenjee keeray ...	Palleroo ...	Do.; leaves used as greens.
113. Urtica tuberosa	....	Pilli dumpa ...	Grows wild; tuberous roots boiled and eaten.
114. Vellarsia cristata*	Nedel ampel ...	Alli gadda, Antara tamara.	This is a species of water lily found in tanks and wells. The substance found in the plant is cooked or merely boiled and eaten.
115. Xanthochymus pictorius.	....	Jevra memadie ...	Grows wild; ripe fruits.
116 Ximenia Americana	....	Oora nechra, Konda nakkera.	Do. do. do.
117. Zizyphus jujuba	Yellanday kai ...	Reygoo ...	Ripe fruits.
118. Leptadenia reticulata.†	Palacoody ...	Kalasa ...	The leaves and tender shoots used as a vegetable in the Vinucondah taluq, Kistna, at all times.

† This plant was sent to me by the Collector of Kistna for identification, and "that it was eaten by the villagers of Vinucondah taluq as a vegetable, but which they are now using as food." I have identified it as the Leptadenia reticulata. (Signed) J. Shortt.

Note.—Names marked thus * are taken from Mr. H. Yarde's (of the Forest Department) list.

(Signed) J. Shortt, M.D., *Surgeon-Major*,
Inspector of Vaccination, Madras Presidency.

Madras, *3rd May* 1877.

The Effect of Pruning on the Growth and Shape of Trees.

I.

The uses of Forests are two-fold: primary ones, such as the regulation of rain-fall, cooling the atmosphere by enlarging the surface of radiation set; and secondary ones, namely, the supply of forest produce.

The primary uses of forests are more general in their effect; they do not merely benefit the owner of the forest, but the community at large, and being so extensively beneficial, their value cannot be estimated with mathematical correctness. It is far different with the secondary uses; their value is patent; they are the offspring of artificial conditions and give rise to many branches of forestry: they are, moreover, easily calculated, and it has of late become the fashion with continental foresters to regard a well-stocked forest as a capital which must pay interest, and every sylvicultural operation as an investment which must repay the original outlay with interest. This point of view, though justified in the case of a private land-owner, is not the correct one for the State to assume, as the most important primary advantages are left out of consideration.

The measurement *of trees is found to be the basis* on which all the calculations respecting the value of forests, all the data required for the more elaborate working plans have to be based; and it is evident that without such measurement neither the relative value of trees can be ascertained, nor the shape *most desirable from a commercial point of view. It* will, therefore, be necessary to examine a few problems of mensuration before proceeding further.

II.

The shape of trees is a result produced by the co-operation of many factors; the prevailing wind will retard the growth of the branches on one side, a rock will arrest the roots on a second side, or a second tree close by will prevent the roots from spreading and the branches from expanding. All these obstacles combine to cause an irregular distribution of the

branches and roots of the tree, and a corresponding eccentricity in the development of the trunk. A tree showing a perfectly regular growth or a perfectly circular cross-section is therefore a great rarity; and, though trees are measured by the application of mathematical formulæ, it is always understood that the results thus obtained are merely approximations, though quite near enough for all practical purposes.

The cubical contents of a log are calculated according to the formula $r^2 \pi l$ — the area of the cross-section in the middle multiplied into the length of the log. The formula quarter mean girth squared into length is generally employed in this country, but having no mathematical basis it is useless for the purpose of the present paper.

The radius is found by taking the mean of two or more measurements, care being taken that no measurement is taken in any place showing an abnormal enlargement or depression. In such a case measurements must be taken at two places, one above, one below, but equidistant from the middle; the mean of the two results will be the radius of the log.

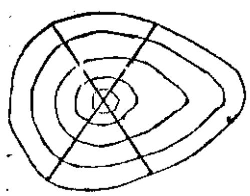


Fig. 1.

The cubical contents of a tree are found by dividing it into pieces 3 or 4 ft. long, and calculating each piece separately as a log, or by multiplying the sum of the areas of the cross-sections in the middle into the length of one piece, the formula being $v = s \times l$; here v = cub. contents, s = sum of the areas, and l = length of one piece.

The first piece 4 ft. from the ground is irregularly shaped, owing to the buttresses of the tree: it is also calculated as a cylinder, but its diameter is measured at a point 4 ft. from the ground and not in the middle. In the present paper this piece is always separately calculated, the point 4 ft. from the ground is called the base of the tree, a distinction being drawn between the base and the foot of the tree.

In comparing the trunks of trees (the portion above the base only) with mathematical figures, they were found to resemble the cone and paraboloid, sometimes more nearly

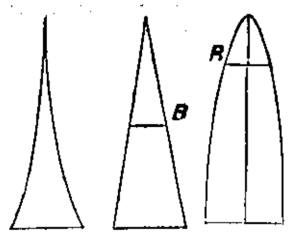


Fig. 2. Fig. 3. Fig. 4.

approaching to one, sometimes to the other. Trees less full-wooded (Fig. 2) than the cone, or more full-wooded than the paraboloid, are exceedingly rare, but even in such cases the formula explained further on will be found nearly correct.

The formula for the solid contents of the cone is—$V = \frac{r^2 \pi \times h}{3}$, for the paraboloid $V = \frac{r^2 \pi \times h}{2}$.

The diameters of the cone measured at different heights decrease more rapidly than those of the paraboloid, if measured at the same elevations. Thus, in the case of the cone, the diameter is reduced at midheight to half of that at the base, whilst in the case of the paraboloid the diameter is reduced to an equal extent at an elevation equal to $\frac{3}{4}$ths of the distance from the base to the top.*

Point R (Figs. 3 and 4) at which the diameter is equal to half the diameter at the base is called the guiding point; its distance from the base is variable in trees of different shapes; thus trees resembling the cone will have it at midheight, whilst those resembling the paraboloid will have it at $\frac{3}{4}$th height; it is a most useful guide in judging of the shape of trees. Trees shaped like the paraboloid yield a longer and more cylindrical piece of timber than those shaped like a cone. For example, if two trees are supposed to have the same diameter at the base, say two feet and the same height (84 feet), and supposing 1 foot to be the minimum upper girth of timber, then the tree shaped like a cone will yield a log 44 feet long, whilst the other tree shaped like a paraboloid will give a log 64 feet long, that is to say, 20 feet

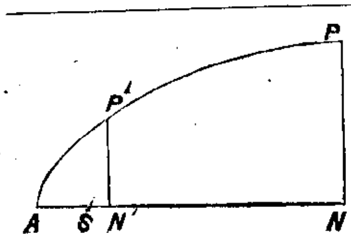


Fig. 5.

* The proof in the case of the cone is too simple to require further reference. The proof for the paraboloid is as follows:—

$AN = x$, $NP = y$, $SA = a$, $AN' = x'$, $N'P' = y'$

Then $y^2 = 4ax'$

$y,^2 = 4ax'$

$y^1 = \frac{1}{2}y$ and $4y,^2 = y^2$

$\therefore 4ax = 16ax$ and

$x = 4x'$ or $AN = 4AN'$

and $AN' = AN - AN' = AN - \frac{1}{4}AN = \frac{3}{4}AN$

Q. E. D.

longer and more cylindrical, therefore more valuable than the shorter log. An operation that causes the tree to assume this second and more valuable shape must be considered of the highest importance.

If the superficial area of the cross-section of a tree at the base be called A, the height of the tree h, the distance from the foot of the tree to the base m, the distance from the base to the guiding point g, and the distance from the foot of the tree to the guiding point g′, then in the case of the cone $x = \frac{1}{2}$ h, or $h = 2g$, in the case of the paraboloid $x'g' = \frac{3}{4}h'$ or $h' = \frac{4}{3}x'g'$. Substituting these values in the formulæ for the solid contents of those bodies we get:

Volume of cone $= \frac{A \times h}{3} = \frac{2}{3} A\,g$.

Volume of paraboloid $= \frac{A\,h'}{2} = \frac{A}{2} \times \frac{4}{3} g' = \frac{2}{3} A\,g'$. G and g′ are quantities found by measurement, and the general formula for calculating the contents of the trunk of a tree above the base, is $V = \frac{2}{3} A\,g$.

To obtain the contents of the whole tree the small cylinder at the foot of the tree has to be added; its solid contents are $= A \times m$.

The formula for the entire tree therefore is:

$$V = \tfrac{2}{3} A \times g + A\,m = A\left(\tfrac{2}{3}g + m\right)$$
$$= \tfrac{A}{3}(2g + 3\,m), \text{ but } g + m = G \therefore$$
$$V = \tfrac{A}{3}(2G + m) = \tfrac{2}{3} A\left(G + \tfrac{m}{2}\right).$$

The results obtained by this formula will be found surprisingly correct if compared with those obtained by the more tedious sectional method. Care must, however, be taken that the guiding point is not unduly raised or depressed owing to accidental irregularities of the trunk.

This method has been successfully applied to the mensuration of standing trees; what is more it is now possible to calculate the annual increase of a standing tree in cub. feet. As the timber producing portion of the tree is chiefly under consideration, it is needless to explain here the methods for estimating the cub. contents of the branches of a tree. Little is known regarding the quantity of the roots, as they are rarely utilized.

III.

In the last section it has been shown that trees resembling the paraboloid have the most desirable shape for the supply of timber, as they yield the longest and most cylindrical log; but a large girth is also a great desideratum. The organs active in nourishing the tree are the roots and the branches. An isolated tree, with plenty of room for the branches and roots to spread may, therefore, be assumed to be in the most favorable condition for the production of wood, but the branching point will be low down, the log covered with knots, and though the quantity of wood produced will be large, yet the log or timber portion will be small, that is to say, the branches predominate over the trunk, the comparatively valueless over the more valuable portion. Timely pruning will, to a great extent, remove these drawbacks; and, as will be shown further on, will also improve the shape of the tree. Another consideration is that trees planted far apart do not extract nourishment from a large portion of the ground for many years, and that the ground remains uncovered for a length of time rendering the accumulation of vegetable mould impossible. Close planting, on the other hand, produces long, clean, and straight stems, but they are generally deficient in girth, and even if a few picked trees are allowed to stand over, they often wither when suddenly exposed to atmospheric influences. A judicious mixture of various kinds of trees seems most favorable to the production of large and valuable timber, if assisted by well-timed and carefully-conducted thinnings, especially at the time when the trees have nearly completed their longitudinal growth.

The attention of Indian Foresters has been drawn to this most important subject of "mixed forests" by no less an authority than Dr. Brandis; and it is to be hoped that forest officers in this country will not go too far in their endeavour in reducing their natural mixed forests to pure high forests. For the jardinage forest is eminently the home of large timber trees, and some of the experiments of the foremost continental foresters seem to lead us back to the jardinage system, to which many of our Indian forests most closely resemble. Coppice, with standards, also produces large timber, but the periodical

cuttings being regulated by the growth of the coppice, comparatively little care can be bestowed on the standards; consequently either the standards become too numerous and destroy the coppice, or the standards will become so few as materially to lessen the value of the yield. After visiting and examining some of the finest coppice with standard forests on the continent, one cannot shake off the impression that this system, though in places highly successful, is on the whole most objectionable and highly unsuited to this country. But it is not possible in this or in any other matter connected with forestry to lay down hard and fast rules, and the welfare of the future forest depends on the judgment of the forester.

It has thus been shown that large timber can be grown by planting trees far apart, that a greater quantity of wood in the individual tree (not on the whole area stocked) is produced, but that there is comparatively little timber and of a less valuable kind. Close planting produces larger and straighter stems, a larger quantity of wood on the whole area that is stocked, and a much larger proportion of timber, nor is the timber under proper management deficient in girth. Close planting represents a natural system of pruning, the lower side branches, being deprived of light and space for spreading, wither, die and drop off, leaving a clean straight stem. Having examined some of the general conditions effecting the growth of timber, we can now proceed to the laws relating to the growth and shape of trees which will enable us to see the effect and value of pruning.

These four laws are:—

1. The root and leaf* power of a tree are proportionate to each other, and there is a constant tendency to restore the equilibrium, if the one or the other has been weakened.

2. The mass of the annual increment of wood is in trees of the same species proportionate to the leaf power.

3. The outer and upper portions of the leaf canopy are more effective than the lower and inner portions (these latter

* The "leaf power" of a tree represents the sum of the functional value of all the leaves. The functional value of leaves is not proportionate to their size, for young leaves and those exposed to the sun have a greater power of assimilating carbon and nourishing the tree. Similarly, the root power.

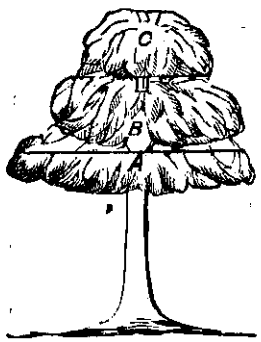


Fig. 6.

being older and less exposed to the action of the rays of the sun.) If the leaf canopy of a tree be divided by horizontal lines into three equal parts, A, B, C, their effect on the growth of the tree will be in the following proportion:—A : B : C=1 : 2 : 4, that is to say, each upper portion is twice as effective as the next lower one.

4. The superficial growth of the cross-section of a tree at any point during a given number of years is proportionate to the leaf power above. From this it follows that (with the exception of the enlargements owing to branches, the buttresses below the base and other accidental excrescences) the cross-section of the trunk at all points between the base and the branching point will show an equal annual superficial increase. Figs. 7 and 8 represent the cross-sections of a tree at two different points—Fig. 7 the upper, and Fig. 8 the lower one; a and a' represent the section of the original tree; the two rings b and b' representing the growth during a year or a number of years, are equal in surface.

Fig. 7.

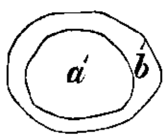


Fig. 8.

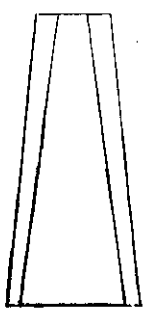


Fig. 9.

The consequence of this is, that the diameter of the upper portion of the tree below the branching point increases more rapidly than that of the lower portion, as the rings lower down are narrower than those higher up, *i.e.*, the tree becomes more full-wooded, and more and more approaches the figure of the paraboloid. A little consideration will show that in this process the figure of the paraboloid can rarely be exceeded.

5. From laws 2 and 4 it follows:—

In trees of the same species, having the same length of trunk, the superficial increment at any point of the trunk is proportionate to the leaf power.

IV.

These laws lead us to the following conclusions :—

1. Pruning, in as far as it diminishes the leaf power of a tree, must retard its growth.

2. There is a constant struggle to make good this loss, which is therefore only temporary. The branches cut lower down are replaced by the lateral expansion of the upper branches.

3. The loss in consequence of pruning is not great, for even if the whole of portion A (Fig. 6), representing one-third of the foliage be removed, the leaf power of the tree will only be diminished by $\frac{1}{7}$th part. Whilst, if the top portion of the leaf canopy, representing an equal surface of foliage is removed, the leaf power will be reduced by more than one-half ; and, as the lower branches and leaves are replaced higher up and in a more favorable position, a less quantity of new leaves will suffice to restore the leaf power of the tree.

4. Pruning produces not only a larger piece of timber, but also causes it to assume a more desirable shape, and to approach more and more to the figure of the paraboloid, whilst a low branching tree may be even less full-wooded than a cone.

5. Occasions might arise, when a knowledge of the laws of pruning might be more directly applied. For example, a demand might spring up for short and cylindrical logs, say 10 feet long ; it seems very probable that a system of pruning, as exemplified in

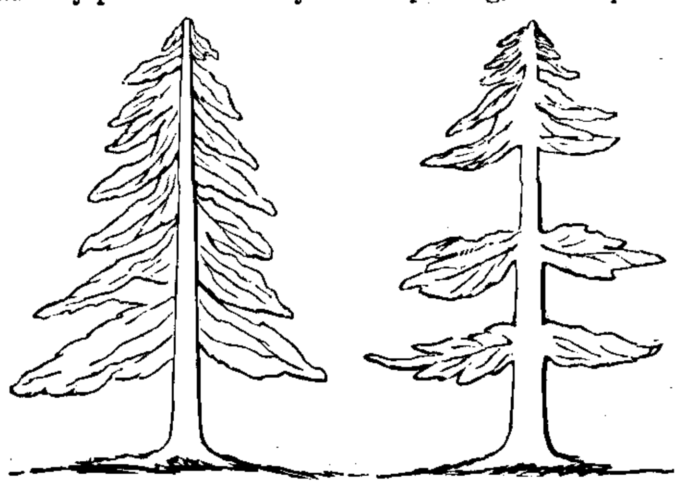


Fig. 10

Fig. 10, would assist in producing timber of the required shape.

The details of pruning are known to every Forester, and there is no necessity for entering on that part of the subject.

V.—(*Appendix*).

For the information of such of the readers as happen to take an interest in the problems of mensuration discussed in the previous paper, an example is appended, which will assist them in forming an opinion of the relative merits of the two methods of tree mensuration, and enable them to make similar measurements, which cannot fail to yield interesting results.

These measurements, amongst others, were taken for the purpose of finding the form co-efficient of a beech forest, 75 years old, in connection with a valuation survey carried out by the writer. It only remains to state that the data were never before used for the present purpose.

The trunk was marked off into pieces 4 feet long (1·169 metres) which were all measured in the middle, except the first piece, which was measured at 4 feet from the ground. The diameters are given in centimetres, and the cubical contents calculated in cubic metres.

No. of the pieces.	Distance of point of measurement from foot of tree.	Diameter in centimetres.	Area of cross-section in square centimetres.
1	4′	23	415·476
2	6′	23	415·476
3	10′	21	346·361
4	14′	21	346·361
5	18′	20	314·159
6	22′	20	314·159
7	26′	20	314·159
8	30′	19	283·529
9	34′	18	254·469
10	38′	17	226·980
11	42′	18	254·469
12	46′	15	176·715
13	50′	14	153·938
14	54′	12	113·097
15	58′	10	78·540
16	62′	8	50·266
17	66′	6	28·274
18	70′	3	7·068
		TOTAL	4093·496

The height of tree 72ft$=18\times1\cdot169=21\cdot042$ metres.

The sum of the areas of the cross-sections$=4093\cdot496$ metres.

The cubical contents of the tree are, therefore, $\cdot4093\times1\cdot169=\cdot477670$ cubic metres.

Second method: The diameter is reduced to half of that at the base between the 14th and 15th pieces, that is to say it is $11\frac{1}{2}$ centimetres at 55 feet from the foot of the tree. The formula is, $V=\frac{2}{3}A\ (G.+\frac{m}{2})$.

$A=\cdot0415$ and $\frac{2}{3}A=\cdot0277$.

$G=55$ft. and $m=4$ft.

$G+\frac{m}{2}$ 57 feet$=14\cdot25\times1\cdot169$ metre$=16\cdot658$ metres.

Inserting these values we get: Contents of tree$=\cdot0277\times16\cdot658=\cdot461426$ cubic metres.

The difference therefore$=\cdot016244$ cubic metres.

It is especially to be noticed how rapidly the diameter decreases above the 11th and 12th pieces, 42 to 46 feet from the foot point and higher up. The branching point was probably situated about 44 feet from the foot point. The diameter, which had only decreased 5 centimetres from the base up to 42 feet from the ground, decreases 18 centimetres up to the top, *viz.*, in 30 feet.

Point R is 55 feet from the foot of the tree, or 51 feet from the base, the distance from the base to the top being 68 feet, exactly at $\frac{3}{4}$ height. The tree has the paraboloid shape; it is full-wooded.

E. F.

III. Notes and Queries.

Form and Manner of keeping the Cash Book.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—Though the subject of Pengelly's letter under the above heading, which appeared in the October 1877 number of the INDIAN FORESTER seems to me somewhat out of place in a Quarterly Magazine of Forestry, as it has no doubt been read by most forest officers, I will attempt to show that the ideas it contains are not such as should be adopted by your numerous readers.

I take it that the Code, when it says that "all accounts must be kept in the most regular and open manner," does not refer to the form or manner in which the Cash Book or any other account is to be written up, for distinct instructions on these points are laid down *in* the Code; but rather that it is intended, as well I think be generally understood if para. 107 is read as a whole, to bar "irregular and separate" accounts being kept up, that is to say, accounts in forms or manners other than those prescribed in the Code.

The proposal to substitute the heads "Revenue" and "Budget Grant" for those now in use in the Cash Book appears to me quite unintelligible. The present head "Cash" includes all transactions except those with the Government treasuries or banks, whereas the proposed head "Revenue" could properly include only such receipts as form the revenue of the department. The second head, "Budget Grant," is certainly altogether out of place in a cash account, in which, according to principles of account, *bona fide* transactions only can be entered, of which "grants" (budget or otherwise) form no portion.

The object of the "Bank or Treasury" columns on either side of the Cash Book form is undoubtedly to assist the auditing officer (not the disbursing officer, who is only required to enter transactions in his Cash Book as they occur,

which most people would, I think, consider a very reasonable requisition), and in order to assist him it is necessary that they should show, quite distinctly from all other transactions,—*Dr. side* :—The sums received by the Divisional Officer from treasuries or by transfer from other departments, or, in other words, all money that comes into his hands from Government with a view to its being expended by him, and the total amount so received by him. *Cr. side* :—The sums the Divisional Officer places finally at the credit of Government, either by paying them into a treasury, or, in the case of book transfers, by entering the amount of revenue received from a Public Department as transferred to the Local Accountant-General for adjustment (which is practically the same thing as paying them into the Provincial Treasury), and the total amount so credited finally to Government during the month.

Advances made and recovered are practically "cash," for their amount is in the officers' own hands as distinct from being at the disposal of Government, and they can be manipulated, so to speak, by him; they must, therefore, be entered in the "Cash" column, as well as the opening and closing cash balances, which are certainly cash, while in the divisional officer's hands, whether he received the actual money composing them from a Treasury or from a purchaser.

I feel rather diffident in saying anything about "Refunds," which appear to be one of those things that nobody can understand ; but I gather the following information about them and their adjustment from a demi-official the Assistant Comptroller General addresed to an officer some time ago.

The Government of India seem to have no objection to Forest Officers receiving as much money as they can get (honestly and according to rule of course) under "Refunds" (V*b*), but the Code rules that the sanction of the Local Government must, in each case, be obtained before any sum can be charged under that head (AIX*a*), perhaps with the object of checking indiscriminate and unnecessary expenditure on that account, there being *primâ facie* evidence that all revenue collected must have been due to Government from the fact of its having been paid. It also appears that the

Government of India, in *their* accounts, make a great distinction in the manner of treating the apparently analogous transactions of "Refunds" credited in the Forest Accounts (V*b*.) and "Refunds" debited (AIX*a*.)

Sums credited under (V*b*.) by Forest Officers remain in the final accounts of the Government of India as Forest Revenue.

Sums debited under (AIX*a*) by Forest Officers are picked out of the Provincial Forest accounts, and entered in the final accounts of the Government of India under a separate major account head "III, Refunds and Drawbacks."

Regarding "Refunds," and the difference between "Refunds" and "Cash Recoveries," this much however has been explained to me. Any portion of an amount finally charged to a budget sub-head of expenditure in a former financial year, the accounts of which year have been closed by the final annual figures of Revenue and Expenditure having been booked (whatever that may mean) in the Comptroller-General's Office, if recovered in a subsequent financial year, has to be credited to V*b* refunds, but any portion of an amount charged in a divisional cash book to any budget sub-head of expenditure during the current financial year, that may be recovered before the close of this financial year, has to be credited in the Cash Book to "Cash Recoveries of Service Payments" (not to V*b* or Refunds), and in the Conservator's office, deducted from expenditure under the sub-head concerned on the preparation of the classified abstract of expenditure.

From this it appears that the Revenue sub-head V*b* of "Refunds" should *only* be used when, owing to the accounts of the year in which the excess charge was made having been closed, the amount paid in excess cannot be deducted in the classified abstract from the expenditure of the same year under the sub-head to which the amount was originally charged. Pengelly apparently was unaware of this when he wrote to the INDIAN FORESTER.

"Very dry, very dry" all this. So is

Yours truly,

OBADIAH.

Mr. Buck on Moisture from Forest on the Himalayas.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—In a valuable note by Mr. Buck, Director of Agriculture, N.-W. P., on Col. Corbett's book (The Climate and Resources of Upper India) the following remarks are made:—

"It may be admitted as an axiom that trees are a powerful engine in the production of coolness and moisture, and that their growth throughout a country afflicted with dryness and heat should be promoted. * * * * No doubt, we have been doing a great deal to maintain the woods of the sub-Himalayan regions * * *, but the question still remains whether belts of thick wood in the Terai, or luxuriant forests on the Ranges of the Himalayas, will add moisture to the arid climate of Doab, or give rain to the famine-stricken plains of Bandelkhand. The effect of an edging of verdure along the mountain boundary of the north, upon the climate of the wide-spreading plains of the south, is so remote as to be inappreciable."

This extract calls attention to a very curious and interesting study, contributions to which many forest officers would be able to supply. I think Mr. Buck settles the matter too hastily; for he forgets that very many streams flow from the northern hill barrier to the plains, and that the water supply in the streams is (or alas! *was*) maintained by the preservation of the "belt of verdure along the mountain boundary." It too often happens, in the part of India with which I am familiar, that the beds of these streams extend for hundreds of miles southward. These beds are now indeed dry, and the upper portion of them only filled during the rainy season by rushing torrents which spend their fury in a few hours, and are absorbed by the sand as soon as they reach a certain part of their course.

This drying up is chiefly, if not wholly, due to the utter denudation of the sub-Himalayan tracts, a large proportion of which are, indeed, not under the control of the British Government.

The Guggur flowing from the hills below Simla is familiar to every reader, and there is evidence that it once watered the

remote state of Bhawalpore, as well as the Sirsa district now so bare and dry.

Mr. Burns, in his "Notes on the Physical Geography of the Bhawulpore State" (communicated to the Geographical Society in 1872), speaking of parts of the state certainly never irrigated by the Sutlej, says: "Every part of this central tract bears proof on its surface that at some former period there must have been large areas flooded with fresh water for a long succession of years." It goes on to say that this is not the effect of fitful floods, but that it shows a steady irrigation as of land where rice has long been cultivated, and that there are fresh water lake molluscous shells found.

This shows that once, before the hills below Simla were reduced to their present condition, the Guggur was a constantly flowing river, carried fertility to plains now dry and sandy.

No doubt, many other instances could be found, and the possibility of effecting *some* improvement in streams like the Guggur, and (though it cannot be done in the few years of our administration) preparing the way for the restoration of the permanent water supply, is the chief reason why we so continually urge the care of the forests on the hills, and why every educated forester looks with such amazement on the obstructiveness of the Madras Government, which even now after such an ordeal as the hardly yet to be called "late" famine, and with the fact staring it in the face that, while it is largely dependent on tanks for irrigation, those tanks derive their supply from the hill ranges, yet persistently refuses to take steps to demarcate and conserve the water catchment areas and the slopes of such hills.

We need not give vent to any extravagant theories about trees and moisture; but, if one fact is more certain than another, it is this, that water catchment areas will cease to act, and tanks dependent on them will be dry, unless forest is conserved on their slopes.

I am, yours,
J. K.

Pruning Fruit Trees.

Extract from The Garden, December 15, 1877.

"AUTUMN or early winter is the best and most convenient time for pruning most hardy fruit trees. There is usually at the fall of the leaves more leisure to give the necessary thought and time to the work. Every season brings its work, and when the pruning is put off or delayed, it is often hurried over and ill done. When pruning is performed in autumn, there is time for the wounds to at least partially dry and heal, before severe frost sets in. I need hardly say that pruning should not be done during severe frost. It is now pretty well understood that at no season are the roots altogether inactive; although in autumn and winter the demand made upon them may be less, because the circulation is more languid, yet the movement of sap to all parts of the tree must even then be going on; and this brings me to another argument in favour of autumn pruning. If we assume that a constant circulation of sap is going on from the roots to the branches and buds, and we reduce their number, we must add to the strength and vigour of those that remain. The knife must be sharp, so that the cuts may be clean and short. Unskilful or thoughtless pruners often make long ragged wounds which not only look unworkmanlike, but expose a large lacerated surface to the drying influence of the air. If in cutting off or thinning out branches a saw has to be used, it should be a thin narrow-bladed one. All branches should be cut off close to the limps from which they spring, and the surface of the wound should be cut smooth with the knife. A little tar or pitch rubbed over the wound will keep the air and rain from it, and encourage the formation of new bark. Overcrowding branches in fruit trees is just as great an evil as overcrowding plants in the garden or field, and it has just the same debilitating, pernicious effects. At the same time it is obvious that the definition of the term overcrowding must be left in a great measure to be dealt with by the common sense of individual cultivators. The whole economy of the tree depends greatly upon the regular healthy action of its leaves or lungs; and if they be densely crowded—hid away, as it were, from the sun and air—their action must be damaged and restricted, and the whole system of the tree put out of order. Of course, this does

not happen all at once; it goes on for years, the leaves and fruit gradually decreasing in size in proportion as the head of the tree becomes thick. until, at last, neither is produced, except at the extremities of the branches, where they are fully exposed to light. Anybody who has had to do with neglected orchards must know that such trees are common enough, and must have at times experienced a difficulty as to the best mode of treating them in order to restore them to health and fruitfulness. There is a great dissimilarity in the growth of fruit trees of any given kind; some require but little pruning, but all are benefited by having the branches properly regulated and thinned to admit air and sunshine, so that the trees may have their crop or load of fruit hung regularly all over their branches, and not merely swinging in clusters at the ends, where half, or sometimes more, are blown down, or so bruised by the wind as to be useless for keeping.

"In pruning neglected trees, there is always a danger of doing too much at once. If we thin out a neglected wood or plantation of timber trees too severely, we let in the wind, and the cold air chills and stunts the growth, and the thinning may do harm; but, if we thin gradually, removing at first a few of the useless trees gradually letting in more light and air, the trees gather strength, and are soon able to appreciate the freedom of breathing, and the bracing currents to which they had long been strangers stimulate and invigorate both roots and branches. In like manner, in dealing with neglected fruit trees, we must proceed cautiously. All shoots that cross or rub against each other should be cut out, and all young, suckerlike shoots, that often spring from the main branches of old trees, should be cut off or wrenched off close to the stem, to prevent others growing from their base. There are many weighty reasons why fruit trees of all kinds should be regularly pruned. If this were done, the little regulation that would be required would give the trees no check. Whenever an ill-formed branch is crossing, or in the way of, a better one, it should be removed at once before it becomes large. In a cold spring, a thick, overcrowded tree, where the blossoms are mostly at the ends of the branches, has not the same chance of furnishing even a partial crop as when the flowers are more equally distributed. A thickly-branched tree, from the absence of light and air, and the confined atmosphere which such crowding generates, encourages the formation of Moss and Lichens, which not only form

a hiding-place for insects, but militate against the bark performing its natural functions.

"Wall and other trained trees are often too much crowded with growth; not only are the main branches trained too closely, but the spurs are too numerous; the leaves, from being too crowded, lose substance; and, as a matter of course, the buds which they nourish at their base partake of the like weakly character. When a tree from any cause becomes starved or stunted, the sap vessels in the inner bark lose their elasticity and become shrunk, if I may so term it; and, if something be not done to afford relief, the tree will gradually perish of inanition. Hundreds of trees die in this manner long before old age is reached. In such cases heading down, or a severe thinning and shortening, will infuse new vigour into them, and with the new growth will come new life and new powers of production. But at the same time the cause of unthriftiness should be sought for and removed It may be unsuitable soil, overcropping, or the exhausting effects of insect attacks, and the latter often follow in the wake of the former, and are generally found in combination with them."

E. HOBDAY.

Expected Visit of a French Forest Officer to India.

WE hear that the French Government has resolved to send a forest officer to examine and report on the forests of Cochin-China. The officer chosen is M. Behr,* Sous-Inspecteur, and he is to pass three months in the Indian forests on his way to his new appointment. We have no doubt that all forest officers, and especially old students of Nancy, will be delighted to show M. Behr every attention, and afford him every facility of seeing as much as possible of the Indian Forests and of Indian Forest work. M. Behr is expected to arrive in April.

* Probably Bert.

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Notes on Sandal.

THE intention of these notes is more to arouse discussion in those interested in sandal than *to furnish a general description* of the tree, *Santalum album.* Nearly all that is known about it is embodied in its description in Brandis' Flora, and is quite enough to satisfy the requirements of the general reader.

On the Mysore plateau, overlapping the coffee zone, and going east to about thirty-five inches of rain, is a well marked belt of sandal. Beyond this the tree extends scattered all over the province, turning up in the most curious situations, protected by its monopoly from open wilful damage, but still suffering much directly and indirectly at the hand of man. Geographically, there are three classes of trees, each with its own hopes and fears—those in open dry forest or coppiced scrub, those in moist garden land, and those on the borders of dry cultivation. The first dies out with the denudation of the land it is on; the second owes its fine growth to the artificial shelter and moisture of its position; the last derives a mixed advantage from its human associations. Its long running roots, just out of the way of the teazing plough, benefit largely by the husbandman's industry, but it is more than paid out in bark injuries.

Sandal has a constitutional horror of mutilation, though otherwise it is a hardy tree. As a seedling it will stand nothing but the most careful ball-lifting; at that age a few insect bites on one side of the root kill it on the spot, and it seems to lose at an early age the power of closing over

ruptures of the cambium layer, unless they are small or the tree is in very vigorous growth. We had long suspected the existence of this temperament; but lately, while examining sections of the wood for a different purpose, a very clear demonstration of it was obtained. The description of a few of these sections here given will speak for itself:—

SECTION 1.—A tree growing by the side of a road, much exposed to bark injuries from the rubbing of cattle, &c., against it, cut just above the ground level. It exhibited two partially joined stems, with about half the sectional area hollow or composed of imperfect heartwood; exteriorly, the marks of numerous old injuries to the bark.

SECTION 2.—The same tree, but taken at five feet from the ground,—heartwood almost too irregular to measure, perfect and imperfect duramen occurring in blotches through its mass, the bark shows the marks of several old injuries. One of these is cicatrized over, leaving about a square inch of whitewood surrounded by heart. There are two large wounds on the outside, one nearly covered, but the other, though an old one, gaping hopelessly.

SECTION 3.—Taken at the base of a tree growing on open pasture land, itself past every maturity except the physical, but of rather better growth than its fellows about. This section showed very distinctly the two series of zones generally observable on cutting a sandal tree across, the first structural, which might be annual, though it is probably not; the second and most distinct, extending through the heartwood and marking the successive lines of deposit as the formation of heartwood proceeded. As always, both series of rings are far too confused to count. The section shows one small unclosed injury not extending far inwards.

SECTION 4.—Of a tree growing under exactly the same circumstances as the preceding taken at the base. They are both on a deep rich red loam. Both structural and deposit rings are indistinct and wide apart, and there is much imperfect heartwood formed behind an old covered-up wound. In the middle a hollow of about two square inches sectional area filled with white ants' mud.

SECTION 5.—Also of a tree growing on open pasture land. It seems to have suffered a good deal from the rubbing of cattle against the bark. This section, taken at the base, shows distinctly where a recent wound has killed the whitewood to the depth of half an inch.

SECTION 6.—The same tree, taken at five feet from the ground. It shows two old injuries now merely heart shakes, two recent gaping. One of these has killed the whitewood behind it, and the circulation of the sap, thus forced to diffuse round this obstacle and influenced by it, has encased it with heartwood.

SECTION 7.—Taken at the base of a large tree growing in a sheltered rather moist situation. A very large wound now almost covered has made the piece rotten to its centre.

SECTION 8.—Taken at the base of a tree grown partially sheltered from external injury by a hedge. Its aspect is curious, neither heartwood nor whitewood shewing any lines, the former being mottled and but slightly fragrant. The alburnum shows a long strip of dead wood running from the duramen to the bark, which is here peeling, a result, sometimes, of exposure to the sun or the east wind.

These sections were all taken from old living trees, not selected, but of average quality and growth. Further evidence on this point is furnished by the situations in which trees with a hollow or defective heartwood are found. In thickets, hedges, garden land, or anywhere where they can develop unmolested, the stems, unless affected by some other agency, are round, clean, and well formed, and only when the tree is very much "sur le retour" or quite in the decline of its vegetation, does the rough, closely-applied, hard brown bark show any disposition to crack and separate from the wood. If such a tree be cut across, the heartwood will be found with an even contour and regular structure throughout, without a blemish—the wood of paper knives and work boxes, for which the careful Chinaman is willing to pay such a heavy price; in colour varying from a light yellow to a sepia brown, and surrounded by from one to two inches of whitewood. There is, on the other hand, the tree growing on grazing lands, by the side of roads and other

exposed places with a small leaf of an abnormally light colour, becoming stag-headed at an early age, with perhaps merely a narrow strip of sound bark on one side, by means of which it carries on a lingering and unsightly existence; its interior, a gaping cavity, probably partly filled with white ants' mud and lined with shreds of a dark-coloured and highly-scented heartwood.

Perfect heartwood, white ants will not touch. There is a story of an economically inclined and artful Rajah of Coorg in the olden time who prepared his sandal for market by putting billets of it in white ants' nests. Either he must have had very little sandal to prepare or the white ant is one of those species which, in the struggle for existence, has fought a losing battle; for the insect, as we know it now-a-days, would be unequal to such a task. There is a point to notice in connection with this, namely, that although the full dose of essential oil in the perfect heartwood is too much even for the white ant it shows a partiality for the white-wood as soon as any interruption in the regular circulation of the sap places it—the white wood—at its disposal, and very soon cleans out not only this but the faintly scented *imperfect duramen* which forms at the back of a bark wound. It may not be out of place to say a word about this imperfect heartwood. Generally, it is observed extending from a bark wound above, below, and centrewards. We take it to be caused by the gradually drying up, alburnum, tissue, behind a bark injury, being able to exert for a short time an influence similar to that of old cells whose functions are ceasing, causing a thin premature and generally superficial deposit of essential oil. It occurs as greyish brown patches of dead wood with a very faint odour. The heartwood often pointed out by natives as bursting through the sapwood and constituting evidence of the trees being fit to cut is this or merely dry old white-wood; in either case no indication of the age of the tree. There is another explanation of the formation of imperfect heartwood. It may be caused by the simple death of the whitewood behind a bark injury and the communication to it of the odour of the perfect heartwood in its neighbourhood;

but this is unlikely, as its smell is strongest on the outside, or that farthest removed from the perfect duramen.

The spotted wood known in Kanarese as Nāgā and Nāwal kanu—snake's and peacock's eye—for which natives will often pay an enhanced price, has an analogous origin. Adventitious buds die and their course from their origin outwards can be traced by a dark line of rich deposit, appearing on the longitudinal section as more or less annular spots. This abnormal development of adventitious buds is probably a disease, or at any rate symptomatic of weakness in the subject. It generally occurs in ill-favoured trees, and is accompanied by much imperfect duramen.

The gradual destruction of the scrub forest or grazing lands is affecting the sandal, not only by permitting a freer access of cattle, but by the evils generally attendant on denudation, desiccation, and deterioration of soil, exposure to dry land, winds, &c. On these lands sandal reproduction is very much in inverse proportion to the extent to which clearing has proceeded. On cutting a way through, or crawling into, the scattered thorny clumps which abound in these localities, the light-coloured sandal seedlings or suckers can be easily discerned, but it is almost needless to say that out in the open a seed rarely germinates, and when it does, its delicate leaves and shoots are speedily browsed to the ground, and the plant killed.

Thus, to resume : Sandal grown in exposed situations yields a heartwood generally only of use for burning and distilling; natural reproduction has been much reduced latterly, and may be expected to be more so in the future. Taking the province through, the greater part of the fine carving wood is produced in the numerous patches of garden land—"nut topes," in country-bred phraseology,—studding the face of the plateau ; if the supply is to be kept up, plantations must be made, and, sites and other conditions being under control, none but first class wood need be produced in them : the production of sandal wood being purely a question of revenue. Unless these plantations can be shewn capable of producing a high percentage on the cost of their formations, there is no

reason for their existence; if they can, the funds so provided would afford a valuable means of planting in a country which much needs it.

The crop value of a fully-stocked sandal plantation cut at 40 years, supposing it at that time to contain 100 mature trees per acre of a net value of Rs. 30 each, will be Rs. 3,000 per acre. Of these two factors 40 and 30 we will consider the latter first. In 1874-75 in the Hassan district, special sanction was obtained for the uprooting of trees only top-dry. Those taken up under these orders were inferior to that which might be looked for as the produce of a regular plantation, but were older—probably in the mean 25 years. Good and bad, they realized as their net value about Rs. 28 per tree, a sum rather below than above what may be considered as the value of a fairly grown tree anywhere in Mysore. This group is taken as an example; because, under exceptional circumstances, living trees were allowed to be cropped, and hence the great mass of long-since-dead rotten rubbish which in a collection of purely dead wood, would vitiate our figures, was absent. The collection, however, still contained a certain number of damaged trees grown on open land. This and the cost of a scattered preparation necessarily much heavier than it would have been in the case of a regular plantation, make the estimation of Rs. 30 as the net value of each plantation tree, a safe one. Four years ago in the course of sandal collection in the Hassan District of Mysore, a tree was felled girthing eight feet and yielding $1\frac{1}{8}$ tons of good heartwood. This giant, which ought to have been preserved as a specimen, was rooted in sandy soil on the banks of a perennial river. Its value would be something near a thousand rupees. With regard to the maintenance of the present rates in the future much official information has been collected and need not be repeated here. While the collection of wood has been in the hands of the Forest Department, the latter's work has been in great measure confined to the utilization of the refuse left by the wretched work of the numerous staff of men formerly employed for this purpose, and yet, on the whole, prices have considerably risen. Though the market for sandal is extended enough to protect it

from sudden fluctuations, it is almost confined to the East. One would wish to see the development of a direct trade like that of coffee, between the Western Coast and Europe, where there is said to be a great and increasing demand for wood adapted for carving, and sandal with its world-wide fame ought to be cheaper and more used than it is. Its reputation is indeed due a good deal more to its perfume* than its structure; and for fine hard carving or engraving it is distanced by many other woods growing in this mild equable climate: an Italian summer with a tropical sun, as some one happily described it. Sandal is what would be termed rather open in the grain and it is besides very liable to split. The medullary rays are comparatively coarse, long, and straight; the pores or vascular openings on the transverse section fill up about half the superficial area. As we understand Dr. Brandis' wood classification, sandal would come under class I A 2. This form and arrangement of the medullary rays, combined with what appears under the microscope to be an unusually straight disposition of the woody fibre cells, may be held responsible for sandal's unfortunate facility for splitting radially when drying. A depreciation of about 20 per cent. in value, for the finer sorts, takes place regularly from this

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*A speculation here arises—how comes sandal to have this odourous oil? Is there anything peculiar in the soil in which it grows, or in the air in which it assimilates? We think not. The climate of Mysore is eminently suited to it—the tree's own, in fact, and a hotter, colder or brusquer one would be bad as it departed from this standard. The tree displays, too, no idiosyncracy in its choice of soils. It looks well in one in which any other tree might be expected to look well, and it is widely distributed. Of what use to the species then is its essential oil? Not functional probably, since it is absent in all the organs of growth and reproduction, not even appearing till the tree is already advanced in life. We know that while the complicated changes which assimilated matter undergoes, before it is finally fixed as formative matter, are going on, (metastasis), certain bye-products are formed which are of no further use to the species, which indeed lie henceforth inactive and seem to have escaped the vito-chemical grasp of the plant. The crystals of calcic oxalate found in the cells of many species are an instance. They are of no further use to the plant, and a German physiologist has offered an ingenious and natural explanation of their presence. May not sandal oil occurring originally as a bye-product have been increased by evolution to serve the purpose it now does, that is, to protect the ligneous tissue of the tree from the effects of wounds, insects, fungoid rots and injuries of all kinds. The tree is, at least as much as any other, a sufferer in this way; and from its slow growth, softish wood, and general constitution less able to resist. It altogether declines the battle for light fought out in dense forests, a battle we know the hard wood trees of Europe fight and gain in virtue of their superior longevity, a longevity more than doubtfully dependent on their ability to keep their hearts sound by the deposit of matter analogous in this way to sandal's oil. The roots of sandal are peculiarly exposed to injury, and there the essential oil accumulates first and in the greatest quantity, as soon as the thickening of the cell walls and their withdrawal from the active functions of young cells leaves them liable to attack.

cause, while the wood is lying in the stores, between the time that the billets are prepared and sold. It is said that the only way to season the wood so as to preserve it from cracking is to bury it in its own saw-dust, a plan which we have found to be partially successful on a small scale. It is a matter of experiment to ascertain whether the cost involved in keeping the wood for an extra year in large covered pits, where it would be sheltered alike from diurnal variations of temperature and the dry land wind from the N. E., would be much more than reimbursed by the enhanced value of the wood so seasoned. Sandal's present price in Europe seems to place it out of the reach of the German and Swiss carvers, the Paris and *Tonbridge Wells knicknack et hoc genus omne,* but if a sandal trade were to arise in this direction it might also draw along with it some of the ebony now lying about the Ghaut forests, where not unfrequently one stumbles over billets of heartwood all ready for the market, prepared by the rapidly rotting agency of a steamy climate.

With the idea of inducing ryots to grow sandal themselves, or at any rate not to molest natural reproduction, a percentage on the value of trees taken, was some time ago allowed to holders of cultivated land, the percentage increasing up to 15 with the number of years of occupancy—a rule most admirable in itself, but so difficult of application that it had to be abandoned. Could the amount be fixed on the part of the Forest Administration, it is not easy to see how an undue lining of the village accountant's pockets could be prevented. With regard to the sandal monopoly itself, no one seems to know much about it, and there appears to be no record of the time when it did not exist; but the respect with which the tree is regarded by all classes is a deeply-rooted and pleasing feature of the Kanarese mind. Any rapid abolition of the monopoly would be pretty sure, in the first instance, to open the door to much roguery, as it would take at least a generation before the measure were thoroughly understood. It will probably, however, never be contemplated seriously to interfere with an indirect tax so firmly rooted and bearing so exclusively on an article of pure luxury. It does not follow either, that

throwing the market open would be supplying it. Private speculation would fight very shy of planting the tree to any extent; native, from the fear that Government would some day take back its own; and European, from a natural disinclination to embarking in an enterprise of which the first fruits would not be realized till after a residence of 40 years in a tropical climate. Both in fact would have constantly before their eyes the reflection that under a native administration money might not be as abundant in the state coffers as it has been, and that such an easy and popular way of realising it, as the sandal monopoly, would be likely to be resumed.

If there is nobody in Mysore likely to grow the tree, the same reasoning does not apply to other countries which have not the fear of an immemorial Government right before their eyes, and our *factor* might be seriously perturbed by the consideration that unless something is done to extend the market, or at any rate supply it with the best produce, it may be gutted from elsewhere, notably by the exercise of that energy which invariably seizes the Madrasee when he rises a few thousand feet above sea level. True, he has difficulties to contend with; he only holds the fringe of the tree's habitat, but quite enough to make him a very important item in the stocking of the sandal market of the future. Here, in Mysore, going west beyond fifty-five inches of rain the tree can be discerned suffering from the cold and wet of the monsoon. Occasionally there in well-drained and sheltered situations it springs up in great numbers, but falls an early prey to a tortoise-shell-coloured borer which eats out its stem like *zenzera coffeophaga* does that of coffee. The perfume also becomes less powerful and the wood lighter—what one would have expected in a damper climate—but there does not appear to be a loss of odour like that shown when the tree is grown artificially altogether out of its own country. The Hassan District of Mysore is pretty well the centre of the tree's range of growth and its sandal enjoys a certain repute of its own.

Let us now look at the 2nd factor (40), taken as the age at which sandal, under ordinary favourable conditions, attains its "exploitabilité commerciale," or commercial maturity. The

artificial production of the tree, as has been remarked above, can only be defended on purely financial grounds; and it grows so little "en massif" that the mean individual term may be taken as closely approximating the collective term—a simplification. The commercial maturity of a tree or block of forest may be expressed loosely and briefly as *the time at which it pays best to cut it down,* more exactly as, *the age, cut at which, it will produce the highest percentage on its cost* or *on a theoretical capital value*—cost or value including original expense of formation, upkeep, ground-rent, and in fact all working expenses. Ground-rent, or the value of the space occupied, must always be included, though none be paid; since by putting off cropping for a year we lose a year's growth out of the succeeding crop.

Many years hence it may be possible to apply the full equation $C=\frac{R}{(1+t)^{n}-1}$ (where C=capital value: R=revenue: t=interest rate: n=number of years or rotation); each homogeneous block being cropped at a term corresponding to the greatest value for (c); but at present the necessary data are wanting.

We are considering here the simpler case of a plantation of pure sandal, taking the total cost of formation and upkeep as compared with the value of the resulting crop, enquiring what is the profit or loss on the transaction. The power represented by (n) in the formula for compound interest is a very important one, and here again the meagreness of our data is forcibly felt. An exact mean value for (n) could only be obtained generally as the result of systematic observation over a regularly worked tract, and in the case of sandal, hardly, except in an old established plantation. A good approximation to the truth might have been got at by a periodical examination of individual cases with well-authenticated ages; but general enquiries from however great a number of persons can be but little relied on. We have utilized a few days' leisure in the attempt to find what we hope is nearly the term of the commercial maturity for sandal, visiting trees whose age was said to be known, examining the evidence tendered and estimating from appearances, forwards or backwards. In doing so "the physical maturity"

has been included wherever possible, this being of interest as that at which the natural grown tree is cropped at present. It was intended to uproot, prepare and weigh the heartwood in each case examined, but this was found impracticable with the time at command; and from authenticated ages occurring so frequently in damaged trees, misleading figures would have been obtained. It is, besides, easy to estimate within a few years the term at which the commercial maturity falls by observing the development of the heartwood—at what depth the perfect duramen is below the surface at different heights up the trunk, and how far into the branches it has extended. It is a general rule that a tree of any cut has *reached its commercial maturity, shortly after it has attained* its lowest marketable standard, and that the term cannot be long deferred after any sudden rise in the tree's price. Sandal, till the perfect development of its heartwood, is only of use for firewood; but the duramen once formed, such a sudden value is developed, that the maturity is fixed at once. A tree, with the heartwood at a general depth of two inches below the surface, cannot in a year acquire an increased value equal to the interest on its present selling price *plus* the value of the space it would occupy. With these remarks we will proceed to marshal our cases, always apologizing for an amount of detail which only the importance of the subject could warrant.

1st Case.—Age known to Dasé Gowda, of Mudagerri, in whose field the tree is, from his having a distinct recollection that when a boy he jumped up and pulled the tree over to get fodder for his goats. The tree was then of a total height of two big men. The tree shows a decided bend just above the root, and an examination of the first and subsequently formed branches is confirmative of the story. Considering the size of tree which a goat boy could bend, its stated height at that time and its general surroundings, its age then could not have been much above or below six years. Witness, who speaks freely and intelligently, and has no motive for stating anything not the truth, gives his own age as 59 years. He looks like it. Subtracting ten years for his goat-boy age

and adding six, we get the present age of the tree as nearly fifty-five years. The mean girth of the trunk is one foot eight inches, height nine feet to branches. General depth of heart-wood $1\frac{1}{2}$ inches, and it extends into the larger branches. The tree is some years past its C. M.; from all appearances about fifteen, so that the term in this example may be estimated at forty. In the same manner eighty might be taken as the term of its physical maturity.

It may be worthy of notice, as illustrating the comparative slow growth of sandal, that this small tree is growing by the side of a large tamarind, girthing 7 feet 2 inches at 6 feet from the ground, 75 feet high, and with a spread of branches 24 yards across. *Witness states that he can distinctly* remember the young tamarind coming up, about ten years after he had nearly snapped the sandal tree. Except for the bend, which it received in its youth, our example has grown under generally favourable conditions on a good loose soil and fairly sheltered situation. More under the shade of the big tamarind, is another sandal, age unknown, straight, healthy and well-grown, girthing three feet.

Case 2.—This is a tree grown under the most favourable conditions conceivable, with its roots in the made earth of a tank bund about four feet below the mean level of the water in the tank, its trunk sheltered and forced up by the proximity of other trees. Total height of the tree is fifty feet with a regular tapering trunk separating gradually into branches. The same witness remembers, when a lad of about fifteen years, removing the hedge of a little vegetable garden and finding in it a whip-like sandal sapling of about his own height, say 5 years old. It bent over when the hedge was gone, but he straightened and bent it against a neighbouring tree. He has seen this tree—the sandal sapling—every two or three days since in passing along the tank bund, and is certain of its identity. There are, therefore, grounds for believing that our example is, within one or two years, 44 years old now. At the base the heartwood is imperfect and 3 inches deep: at 12 feet from the ground there is none. Its C. M. cannot be estimated to fall earlier than 15 or 16 years hence, or its C. M. has

a term of [illegible] years. Its physical can only be roughly guessed at somewhere about 120 years. Its girth at the base is 2 feet 3 inches, and its total height 50 feet.

Case 3.—Tree growing on a rather stony soil in an exposed situation, on the border of a field belonging to Kungalalli Bádé Ganda, who remembers this tree as a sapling from the fact that when a young man and digging on the border of his field he got into some trouble for destroying three or four adjacent sandal seedlings. He says he was then about 18 years, or, what is a good deal more to the point, that this occurred the year after Coorg was taken by the British. This latter event happened in A.D. 1834, so that the age of the tree may be now pretty confidently put down as 43 years. It is long past its commercial maturity—stag-headed, hollow, and evidently from the aspect of the leafage making no growth. It girths 2 feet 11 inches at the base, and like so many sandal trees divides almost immediately into two. Its total height is only 17 feet, and it may, in fact, be taken as a good example of the inferior class of tree noted above. It is a nearly worthless specimen prematurely old—the total weight of its heartwood and root was found to be only 97 lbs. Its C. M. probably fell 15 years ago, or with a term of 28 years, and it would probably have carried on a sickly existence for about 20 years more, giving it a physical maturity equal to 63 years.

Case 4.—Within a few yards of the preceding, but on a soil slightly moister and less stony, is a sandal tree of a totally different aspect, with the firm, finely-rough, reddish-brown bark, and the broad lustrous, dark green leaf of the tree in its prime. It has, like its suffering neighbour, received many bark wounds, but they are all healthily closed or closing over. When the previous tree was a sapling, this, in the recollection of several men present, was of a size which they described and which would make it then from 20 to 30 years old and now about 65. There is further evidence of its age, in the statement of a man who cultivates the adjoining field and who remembers it as a tree of the thickness of his leg, 54 years ago when there was a famine. This would make it

now about 64 years old. It has no signs of being "sur le retour," though the heartwood is at a mean depth of 2 inches. It has evidently attained its commercial maturity, but it is difficult to say how long since, though 20 years may be taken as the outside limit and ten as the mean. Its commercial maturity may thus be estimated at 55 years, and its physical as somewhere near 110. Its dimensions are, girth at the base 4 feet; total height 30 feet.

CASE 5.—A fine tree, growing in a lane just outside the village of Ijapur, whose Patél says he remembers it 40 years ago being as thick as his wrist. Its age may be estimated at 45 years; mean girth 3 feet 4 inches; total height of tree 30 feet; spread of branches 10 yards across. It is in the full vigour of growth, though it has received some bark wounds; on a soil which is stony below; but the roots may be traced running far and wide into the pulverized mould of the adjoining fields. Heartwood at a mean depth of two inches. Tree's C. M. may be estimated at 35 years; its P. M., at 80 or 90 years.

CASE 6.—Further up the same lane is another tree known to the same witness. Its age is about 30 years. Growing on a loose field soil, with little stone below, and receiving occasional drainings of liquid manure, it is an example of a very rapidly grown tree, but subject, from its position, to a knock from the yoke of every passing plough, it has suffered to such an extent from bark injuries as to be practically valueless. Trunk has a mean girth of three feet four inches and a height of five feet. It would only afford the class of wood known in the sandal stores as "jajpokal." The heartwood is at a depth of two inches in the branches and the tree may have attained its C.M. five years ago.

CASE 7.—Tree growing on the edge of a dry bank above a lane leading from the village of Bobagalli to its well. A very old inhabitant who stated his age to be 76 gave a description of the tree as he could remember it when a boy. It must have been then about 20, and now close upon 96 years old. Girth at base 2 feet 3 inches; trunk 20 feet high; heartwood at a mean depth of three inches, but mixed up with much

imperfect [illegible], the result of a continuous *infliction of bark injuries to which, from the tree's position, it has ever been exposed.* It is of course impossible to estimate the C.M.; the P.M. may be taken as falling at 110 or 120 years, as the tree does not appear likely to immediately terminate its wretched existence.

Case 8.—*This is a collective one,* consisting of 7 trees growing under very favourable conditions on a tank bund with water on one side and a cocoanut plantation on the other. They were put into perfect form by the proximity of shade throwing species, and probably a finer lot could nowhere be found. Their mean dimensions are: girth at six feet, two feet 9½ inches; height of trunk 27½ feet; depth of heartwood 1½ inches. An extremely old man of respectable connections stated that he could *perfectly remember the circumstance of* the hedge round the plantation having been put up on the very days that news was received of the fall of Seringapatam, and that the bund was constructed during the ensuing wet weather. There is, therefore, evidence that the group of trees on the bund are not *more* than 76 years old. *Now this bund is in a line of* traffic; bird-borne sandal seed would germinate readily enough during the first year in the newly made earth, and birds would come in numbers for the sake of the grubs; afterwards fewer birds would visit the place, and it would be scarcely possible for sandal seed to produce plants on the open hard ground. Still later, the up-growth of species of easy reproduction, and the development of those sown in the first instance, would again bring in the conditions necessary for sandal's natural reproduction, and one would expect to find alongside the seven old trees, others of all ages, but of a markedly younger appearance. This is in fact observable. These seven trees are, therefore, probably 75 years old, but certainly not older. *Taking all the circumstances into consideration,* and the assumption *that they are now* 75 years old, they must be credited with a commercial maturity whose mean term is 50 and a P.M. of about 120 years.

Case 9.—A tree in a very conspicuous position, on a stony bank, just outside the village of Hulkunda, blown over years ago into *an almost horizontal position,* but nevertheless in fair

growth at the present time, though the upper surface of the trunk under the abnormal exposure to the sun and bark wounds is a gaping hollow. There is evidence that this tree is now 25 years old, and an examination of the heart-wood shows that it is just attaining its C. M. No reliable estimate can be formed of its P. M.

Grouping these results we have for trees grown under the best possible conditions :—

Case 2 : C.M.=61 :	P.M.=120
Case 8 : C.M.=50 :	P.M.=120
Mean C.M.=51 :	Mean P.M.=120

Grown under favourable conditions—

Case 1 : C.M.=40 :	P.M.= 80
Case 4 : C.M.=55 :	P.M.=110
Case 5 : C.M.=35 :	P.M.= 85
Mean C.M.=43 :	Mean P.M.= 92

Under adverse circumstances—

Case 3 : C.M.=28 :	P.M.= 63
Case 6 : C.M.=25 :	P.M.= ?
Case 7 : C.M.= ? :	P.M.=115
Case 9 : C.M.=27 :	P.M.= ?
Mean C.M.=27 :	Mean P.M.= 89

These averages show a coincidence with the results one would have anticipated. The first group's crop is more valuable than the second, and its C.M. falls a little later. It must not, however, be forgotten that the short term of the C.M. in the third group is by no means sufficient to render the value of its crop comparable commercially with that of the first two. The P.M. exhibits a gradation of longevity, as steady as could be expected from the few examples taken. More cases were examined, but the evidence rejected either from its indefiniteness or from a suspicion of interested motives in those tending it. The growth sandal makes during the first five or six years of its life under varying surroundings is fairly well known, and

the error in what one may perhaps be permitted to term the prehistoric age of our cases may be set down as small. Plantation-grown trees would generally be under conditions as nearly as possible similar to those in group 2, but the best obtainable plantation site would be pretty sure to contain *stretches of inferior soil—stony, dry and hot—when the crop* would come to an earlier maturity. This would tend slightly to lower the general term for the plantation, which in group 2 is 43. These then are the grounds on which we have assumed the value of the 2nd factor to be 40. If it errs, it is *probably on the safe side.* General *opinion* would reduce it. Talk to an intelligent countryman on the subject, and he will tell you that sandal is ripe at *30 years, and by ripe he means* a more advanced age than that corresponding to the commercial maturity. Assuming, therefore, Rs. 3,000 per acre as the crop value of a fully stocked sandal plantation exploited at 40 years, let us turn to the cost. This, for a large regular plantation, may be set down as Rs. 50 per acre—Rs. 30 the first year; Rs. 8 the second, for weeding; and Rs. 12 the present value of protective charges during the rotation. The latter item, more than the first two, would be influenced by local circumstances, and where an extensive system of firepaths was necessary, would be much increased, for sandal could never be grown with sufficient cover to altogether prevent the formation of ground herbage. As a set-off against this, in most localities where sandal plantations exist or might exist, grass has a value, and the hay crop would probably pay the protective charges. There is, further, this to be borne in mind, that a forest of pure sandal would be an unwise arrangement, and a forester's first care would be so to mix shade-throwing species with it as to ward off an intensification of evils like those attendant on the laying down of pure oak. The financial results of such an undertaking would be got at nearly by a simple sum of proportion from the data afforded by a theoretically pure sandal plantation, and the whole would present the grateful picture of a work of public utility, public beauty, and public gain. For an area fully stocked with sandal we have taken Rs. 3,000 as the

crop value, and Rs. 352 as the cost of formation and up-keep, calculated at 5 per cent. compound interest up to cropping time, leaving Rs. 2,648 as the net profit per acre; or, in other words, money invested in this way will give nearly 11 per cent. per annum (more exactly $10\frac{4}{5}$) during the first rotation of 40 years. The original and subsequent cost of the plantation is saddled with an increment of 5 per cent. at compound interest; because it would be on these terms that Government, if a borrower, would obtain money in the market. Contrast this yield of 11 per cent. with the 3 and 4 per cent. of the valuable oak and beech forests, close to their market too, in the Paris basin. A country which can show the former figures ought to be *facilis princeps* in forest matters. The mean yearly revenue from sandal in Mysore—all of course the natural grown tree—taking eight years from 1867 to 1874 has been Rs. 2,30,554, neglecting fractions.

Beyond the first rotation it is of less practical interest to look forward, but there is no reasonable ground of doubt that natural reproduction could be relied on for the second. Sandal will not coppice, properly speaking, but a partial cut through or a complete section of any of the long lateral roots will almost invariably produce a cluster of vigorous shoots. It pays to take sandal out by the roots instead of merely cutting it down, so that the act of cropping a sandal area would put the ground into the best state for the two elements of natural reproduction. How far the tree resulting from one of these root-shoots or suckers is inferior to a developed seedling, does not appear to be exactly known, but there is every reason to anticipate the easy production of a large undergrowth of seedlings in a properly regulated mixed sandal forest. The tree seeds profusely every year beginning often at the tender age of four; and under a good "coupe a' ensemencement" one or two years ought to suffice for the regeneration of the coupe. In stating Rs. 50 per acre to be the present value of the total cost of a properly appointed sandal plantation we do not wish to ignore the fact that the species has hitherto been propagated at a much less cost. The results, however, are not such as could enter into calculations of the yield of an evenly stocked area or indeed find any ready expression in figures. It may doubtless

be often advisable to sow teak and other species *in situ.* The habitat of teak is a wetter one than sandal's; it has a strongly penetrating tap-root, enabling it often to hold out against drought during its first hot weather; it is in some respects hardier and grows sooner out of danger from browsing, fires, &c., than sandal; and lastly, it has a small seed eminently well protected, while sandal's, in size and shape like a small marble, its soft albumen protected merely by a thin shell crumbling beneath the pressure of the finger and thumb, is exposed to a host of enemies and has to run such a gauntlet of dangers that, under the most favourable circumstances, rarely more than five per cent. of the seed sown ever germinates. A sudden exposure to the sun dries up the seedling, a few days' sojourn under water, or in a soil holding water, rots it. If sown out in the open before June, it stands a good chance of being eaten, or dried up by a fortnight's fine weather; if sown later, its roots are not more than three inches below the surface when the hot weather is again on it, and, unsheltered, it must die.

From news received of a sandal plantation established by the Madras Forest Department on the slopes of the Neilgherries, it seems that, there, the planting out of regular nursery raised plants leaves little to be desired beyond a cheapening of the process. There, labour is scarce; here, almost everywhere in the tree's habitat, it is abundant.

After germinating, sandal keeps its cotyledons and stored up albumen for some time below ground; and the radicule develops into a fleshy hook-shaped shoot of which the elbow is all that appears above ground. The plumule may, or may not, when it lifts itself erect, bring up the cotyledons along with it, but the young stem, at this period, from an inch or so below the ground to just above it, develops round its central fibrous tissue an amount of soft white succulent matter (parenchyma), which looks something like a young radish, and which seems to constitute an article of food acceptable to more than one species of insect. The "Ringer" (*Agrotis segetum*) is sometimes a regular plague, and grasshoppers abundant after the rains seem fond of taking an occasional bite, which must

be a small one, not to do the delicate plant very serious injury or kill it. On a cold wet soil this soft matter is apt to rot off, killing the plant in two or thre days.

Now, in a nursery, these infantile infirmities can be guarded against; out in the open, all that is left us is a practical demonstration of one side of the Darwinian theory. We can to a certain extent imitate Nature's prodigality of means, seed being so abundant and so easily obtainable; but we must look on with folded arms while our innocents are dying around us and leaving after the first hot weather a remnant too scattered to be economically protected from browsing and fires, which are then the only dangers to be feared. An examination of a few nursery beds shows that great differences of original constitution exist; and this, in a thickly sown nursery, can easily be taken advantage of, by only putting out the best formed individuals. Out in the open, though, varying surroundings have a great deal more than anything else to do with the first year's survivals. These are generally in groups, and afterwards, it is easy to conceive, the fittest would outlive the rest. From a nursery we get the best constitutioned plants, sowing the luckiest from *in situ.*

We should, perhaps, before dropping the subject, offer a few remarks with regard to the maturity at which the natural grown tree is now cropped. This, as has been already seen, is that known in text books as the "physical," whose term is that of the trees' physical existence; and it will be almost needless to add, in European practice only, finding its application in the case of individual trees left for ornament in parks and picturesque bits of forest doing duty as primeval shade. Caution in forest matters must ever command respect from a consideration of the irreparable effects of precipitancy, but in the case of natural grown sandal left on foot long after it has attained its commercial maturity, it is simply leaving a valuable article scattered all over the country either not realizing a fair percentage on its capital value or in a positively deteriorating condition.* All individual trees or blocks of forest, leaving out

* This in our opinion is the actual state of things at present existant in Mysore, and is the outcome of a rule limiting the collection of sandal to a far too low maximum.

very exceptional instances, are worked, whether by forethought or chance, at terms which can be referred either to the "commercial" or the "economic" maturities, the latter being the practical realization of the "exploitabilité absolue" and the one generally applicable to State Forests. Passing over the various terms corresponding to these two maturities, and not cropping sandal till the realization of its "physical," is certainly striking out a bold and novel line of forest procedure. Up to the absolute maturity, there is the argument that the tree, though in fact an only partially productive capital, is still in the vigour of its growth, is absolutely increasing in value, and is shedding yearly thousands of seeds of which one in a million may eventually become another tree. Passed this, the crop very soon begins to deteriorate—left no one knows where, exposed to occasional peculation, and more than occasional injury at the hands of people in whose way it happens to be, shedding seed it is true, but less abundantly than before, and not the kind which one would choose to propagate from. For the individual absolute maturity of sandal, the term would probably, in the mean, be found to lie between 55 and 65 years. Unfortunately the mean yearly increment of sandal under specified conditions is not known and no recorded measurements or other data exist for its determination. We have never been able to make out rings *clearly annual* in sections of woods of any sort grown in this climate, except, perhaps, teak; but it is more than probable that for some others they do exist: in sandal the rings are not yearly, and are rarely countable. Sandal cropped at, say, 70 years would have little or no more whitewood on it than it has now at 100: the cost of preparation on the whole would be lowered from the fact of the collection being in that case confinable within a definite area, instead of extending over hundreds of square miles. All *immature* uprooting could be readily prevented by requiring a ring of bark to be left unstript round the centre of the tree, if indeed the plan were not adopted of sending the up-rooted trees to be prepared *in toto* at the khoti where, in many cases, the sale of the whitewood as firewood would repay the cost of transport.

It is beyond dispute desirable to establish as early as possible some management scheme for working the natural grown tree, and to do this the first requisite is that the yearly cropping area should be brought within defined limits. There is reason to suppose that the present yearly collection is below the annual production.* In order to retain the present crop, while reducing the present yearly cropping area, we must consent, at any rate, temporarily, to a lowering of the cutting term. Supposing the term for cropping were lowered only thirty years which would still leave it in our opinion above what it ought to be, a golden opportunity for regularization without loss would be presented from the fact that an immense quantity of marketable material would be thrown on the Forester's hands, which he could realize by cutting all trees above a lowered maturity over small areas very nearly as profitably as by cutting all trees as they attained their physical maturity over the whole district. The reduction of the present large cropping area would reduce the working expenses and act as a set-off against any loss of material resulting from leaving dead trees on foot for some years in the coupes falling at the end of the rotation—an evil, which though unrecognized, exists to a large but unknown extent under the present system, where the nominal cutting area is so wide as necessarily to leave portions of it unvisited for many years by the collecting agent. Supposing this plan adopted, one would be able during the first rotation to estimate from the different sizes of each year's coupe, what was the relative richness in sandal of the various areas traversed. At the end of the next rotation the mean yearly increment of the district, or whatever was the unit of area worked, would be ascertainable, since we should know that over a certain area, a certain number of trees had, in a known time, reached a certain standard, and a satisfactory working-plan based on this and collateral knowledge could be drawn up. In our ignorance of the sandal "possibilité" it would be well to preserve the present sanctioned collection,

* Seven years ago the Forest Department applied itself to the task of bringing in the dead wood left by their predecessors in the work of collection, through a staff of mongars working under the Revenue Officers, and it is still bringing in dead wood.

slightly augmented, for the first rotation, and means might be taken by cautiously giving out petty contracts over small areas in the coupes falling at the end of the first rotation, to prevent a large accumulation of dead roots and stumps. For natural grown sandal, *it is scarcely necessary to observe,* that, cleanings, thinnings, and in fact all prefinal cuttings are impracticable. Nothing better than selection cutting would be possible, but selection cutting at random and selection cutting over definite areas, in rotation, with a knowledge that we are working within our "possibilité" makes all the difference between regular and irregular exploitation. What the French call jardinage regularisé, when applied to their higher mountainous coniferous forests and furetage in the working of many coppice forests of the south, is distantly what one would desire to see applied here.

A sandal census of Mysore and Coorg has long been talked of, and efforts under compulsion in this direction have been made from time to time. A close individual examination and accurate classification of each tree would look well on paper and be of some use in drawing up a working plan, but the expense of such a proceeding, with the necessary testing and counter checking of the work, would be enormous, and quite out of proportion to its small utility. A rapid enumeration and throwing into classes is of little use as a forecast of future crop, since one tree of a certain age and class might, from circumstances, be worth ten of its fellows; and another looking exteriorly the same might have no value at all from the retarded or non-development *of its heartwood. In the semi-malnád* taluks which are all full of sandal, enumeration is in places impossible, owing to the dense thorny thickets in which the trees occur. Here original and test work cannot be got to agree. Old mature trees require a path to be made to bring them out by, and nothing short of cutting down the whole thicket, an act which would in itself ruin the greater part of the sandal, would make an enumeration correct or an estimate of contents of any value.

Taking a general view of the forest situation in Mysore, it might be described as presenting a plethora of sandal with a

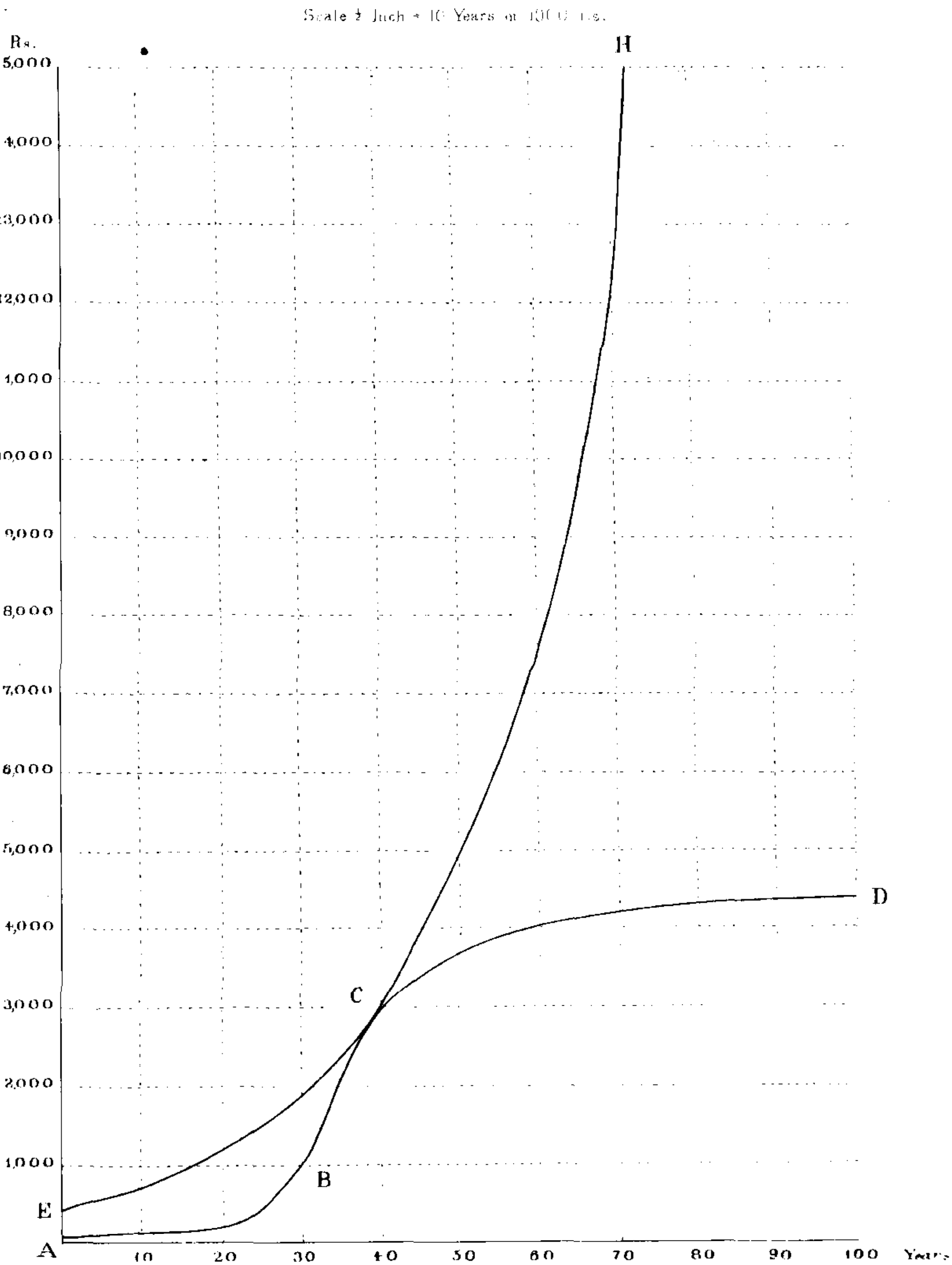
poverty of most else which makes exploited woodlands valuable, and representations something to this effect have, we believe, been made from time to time by the local authorities. Time presses; but here we touch on politics and must cease.

KAD HANDI.

[The accompanying figure is an attempt to show graphically the loss undergone in cutting sandal at a term any other than that corresponding to its commercial maturity. Sandal is perhaps the only case in which a diagram of this sort would be fair. Other woodlands have various indefinite advantages attendant on their up-keep, improvement of soil, civilizing power of cheap timber, climatic influences, &c., but the production of sandal is purely a question of rupees and years.

A B C is a curve representing the market value of an ideal acre of sandal at different ages.

E C H represents the growth of a sum at 5 percent realizable by cropping at the term of the commercial maturity. Below (C) there are two values for the stock, a real represented by the lower curve, and a prospective or discount value by the upper. Above (C) the distance anywhere between the two curves read off along the "rupees" line, represents the loss by not cropping at the commercial maturity. The loss by the present system of not cropping till the physical maturity is arrived at, is greater than admits of graphical representation on a page of the "Indian Forester." By waiting till 71 years the loss is seen to amount in round numbers to a lac of rupees per acre.]


Scale ½ Inch = 10 Years or 1000 Rs.
Rs.
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
H
C
B
D
E
A
10
20
30
40
50
60
70
80
90
100
Years

On some of the Results of Forest Meteorological Observations.

In last November's number of the *Revue des Eaux et Forêts*, M. Rousseau gives the results of some further experiments to determine the value of different kinds of trees in absorbing the rainfall and regulating its discharge so as to obviate the sudden rise of streams and rivers by the reception (all at once) of the bulk of the rainfall pouring off the mountain slopes. In July also, the readers of the *Revue* will recollect, M. Rousseau had an interesting paper "Le cours d'eau dans L'Aude."* The conclusion then was that for reboisement works, destined to cover the slopes which directly fed the river bed and gave rise to sudden floods, evergreen trees were to be preferred (such as *Quercus ilex*) or coniferous trees; the reason of this is that they afford protection against winter as well as summer rainfall, and are particularly good at furnishing a layer of absorbent humus. For three years, as far as his experiments had gone, M. Rousseau found that for all seasons equally, *Quercus ilex* allowed only about one-half the rainfall to reach the ground.

The year's results (1875) as to rainfall were:—

	Under the trees.	Outside the forest.
	mm.	mm.
Winter ...	... 55·1	179·3
Spring ...	... 84·4	162·7
Summer ...	... 169·8	303·3
Autumn ...	... 162·1	323·1
For the year ...	... 471·4	968·4

A very heavy and continuous downpour, such as that recorded between the 21st—24th June 1875, and which caused enormous damage, shows, as might be expected, a less favorable result; for the leaves having got soaked and wet all over do not continue to offer the same dispersive resistance to the fall of the rain drops, and the air also having been fully saturated is less ready to take up more moisture, its reduction in temperature also helping this effect.

* Translated in our last No. for January 1878.

During that storm 108 millimetres reached the soil under the leaf canopy, and 162·2 outside it. Even this was a great gain: it represents 35 per cent.; and the effect would be very great, for supposing 140,000 hectares to be wooded, the sheet of water would have been reduced from 150 mm. to 97, the volume of flowing water from 631 millions to 410, and the flood of the Aude from 5·10 (metres) to 3·60, which would have saved a large portion of the disasters which actually occurred.

In the November number M. Rousseau confirms his previous observations; his experiments relate only to evergreens, as he considers it perfectly established that no others should be used in reboisements of any great importance, *i. e.*, on very dangerous places, and such as the Forest Law describes as *perimètres obligatoires.* Two rain gauges, on the model approved by the *Association Scientifique de France*, have been set up at the same altitude one in the open air, another in the midst, and under the cover of a dense thicket, of *Quercus ilex*, about 20 years old and about 15 feet high. The results, therefore, are the more surprising, as the effect produced by large trees, and especially pines, with much greater expanse of crown and a greater extent of stem and branch, all acting as surfaces to absorb the rain, must be proportionately greater.

Nevertheless experiments beginning in June 1873 gave the following:—

		Rain measured.	
		Outside.	Under.
		mm.	mm.
1873.	1st June to 31st December ...	234·9	48·5
1874.	1st January to ditto ...	907·4	473·5
1875.	Ditto to ditto ...	865·2	435·0
1876.	Ditto to ditto ...	920·9	488·8
1877.	Ditto to 31st May ...	242·1	97·3
	Total of 4 years...	3170·5	1543·1
	Annual mean...	792·6	385·1

On the 6th August 1877, M. Fautrat read a note to the Academy on the results of his experiments at the Forests of Halatte

and Ermenonville. These have been continued since 1863. The experiments embrace both the degree of humidity in the air, and the quantity of rainfall inside and outside forest shelter, and comparing also the effect of coniferous forest with that of deciduous. Not only so, but they test the effect of forest in producing a greater fall of rain over wooded hills (for instance) than over bare ones, whether this is due to the more active condensation resulting from the air being cooled by the wooded surface or otherwise.

The figures for 1876-77 may be given as a specimen, taking the annual mean of the readings from August 1876—July 1877.

Degree of air saturation in hundredths.

	Above deciduous forest: Altitude, 122 metres.	300 metres outside: same altitude.	Above pine forest: altitude 104 metres.	300 metres outside: same altitude.	*Under* the pine forest: altitude 92 metres.	300 metres outside: altitude same.
Total	788	755	739	664	417	336
Mean	71·6	68·6	67·1	60·4	69·5	56
	Diff. in favor of forest even though deciduous, 0·03		Diff. in favor of *pine* forest, 0·07		Diff. in favor of pine forest (under it) 0·13	

A similar Table for the same period, as regards rainfall, gives the following result, taking, to save space, the annual total rainfall only.

Rainfall from August 1876—July 1877 (millimetres.)

Deciduous Forest.			Pine Forest.		
Above the forest (altitude 122 metres).	300 metres outside (altitude 122 metres).	Underneath the forest (altitude 108 metres.)	Above, altitude 104	300 metres outside, altitude 104.	Underneath the forest.
932·00	901·00	649·00	848·25	792·20	397·00
Difference in favor of forest 31 mm.			Difference in favor of pines 56 mm.		

These results tend to show not only that forest has an effect in causing a greater amount of rain to fall than falls over barren lands, but also that pine forest has a greater effect than others: (the forest here was *Pinus sylvestris*.)

The deciduous forest allowed 58 per cent. of rainfall to reach the soil; the pine forest allowed less than 50 per cent. so to reach. The *Revue* for February 1878 brings us in a still further contributions from M. Fautrat, of his meteorological experiences. This time the subject is the cooling effect of forest growth. Again in the deciduous forest of Halatte, and in the pine forest of Ermenonville experiments with thermometers at 1·40 m. above the ground inside and outside the forest, were taken.

The figures are too bulky for us to give in detail, but the temperature in the deciduous forest was diminished in the hot months of June and July, by 0·7 and 0·8 degrees, and under pines during the months of May, June, July, August and September by 1·10°, 0·9°, 1·10°, 1·50° 1·60° respectively.

The differences of temperature in the *open* was also remarked, for both were taken at nearly the same altitude, Halatte being 108 metres above the sea level, and Ermenonville 92; moreover the places are only 8 kilometres apart, hence the difference, which shows Halatte nearly always one degree less than Ermenonville, is attributed by M. Fautrat to the soil. Ermenonville has a coarse grained white sandy soil; Halatte has fine sand cemented with clay and iron oxides.

Readings were also taken comparing the thermometers at 1·40 metres above the soil, with one at 14 metres, and then thermometers at different heights were kept both inside the forest and outside at Halatte (deciduous forest), in both cases the upper thermometers read highest: at Ermenonville (conifer) above the trees the temperature was higher than under, but (owing to the effect of soil already noticed) the higher thermometer read lower than the ground thermometer outside the forest.

As thus it happens that the temperature is higher above the tops of the trees than it is at their base, a current from below upwards is established in the forest, and around the forest, from the cooler tree-mass to the open plain. These currents, remarks

M. Fautrat, cause in summer (when the differences are most marked) a healthy breeze to blow.

The current also carries up the vapours *from the soil towards* the clouds, and thus establishing a *communication acts as a conductor* of atmospheric electricity: "it is to this, doubtless," adds the author, "*that the property which forests possess of driving* away hailstorms from their vicinity is attributable."

B. H. B. P.

The Rain-Tree of Moyobamba.

Some little while since a paragraph went the round of the papers, describing, on the authority of the United States Consul in the province of Loreto, a tree existing in the forests near Moyobamba, in Northern Peru.

According to the *Madras Times* and *Overland Mail* of December 15, 1877, "The tree is stated to absorb and condense the humidity of the atmosphere with astonishing energy, and it is said that the water may frequently be seen to ooze from the trunk, and fall in rain from its branches in such quantity that the ground beneath is converted into a perfect swamp. The tree is said to possess this property in the highest degree during the summer season principally, when the rivers are low and water is scarce, and the Consul, therefore, suggests that the tree should be planted in the arid regions of Peru, for the benefit of the farmers there."

As always happens in cases of this kind, there have not been wanting those who have taken this singular story quite seriously, and the India Office has applied to the Royal Gardens, Kew, on behalf of the Agri-Horticultural Society of Madras for information about the tree. It may be interesting to some of the readers of NATURE, and it will certainly save future correspondence, if I explain once for all what I have been able to ascertain as to the origin of the fable and the amount of truth which it contains.

Pœppig's "Reise in Chile und Peru" (2 vol., 1835), which contains much useful botanical information, apparently makes no reference to the subject.

I am indebted to Dr. Francis Darwin for pointing out to me a very similar account which appears in the *Botanische Zeitung*, January 21, 1876, pp. 35, 36, in which Prof. Ernst, of the University of Caracas, records his observations upon a tree of *Pithecolobium* (*Calliandra*) *saman*, Benth.

"In the month of April the young leaves are still delicate and transparent. During the whole day a fine spray of rain is to be noticed under the tree, even in the driest air, so that the strongly-tinted iron-clay soil is distinctly moist. The phenomenon diminishes with the development of the leaves, and ceases when they are fully grown."

I found that the specimens of this tree in the Kew Herbarium brought its range close to Moyobamba, as they included some gathered by the traveller Spruce, near the neighbouring town of Tarapoto. It appeared probable, therefore, that the Tamia-caspi—the name given in one variant of the story—was *Pithecolobium saman*, though the cause of the rain was more mysterious than ever. Being vouched for by so competent an observer as Prof. Ernst, its occurrence could not well be denied, while on the other hand, the *Pithecolobium* being a well-known cultivated tree in the West Indian Islands, it was quite clear that if the "raining" from its foliage were a normal occurrence, it would long ago have been put on record.

Mr. Spruce has, however, obligingly supplied me from the astonishing stores of information which he possesses with the true history of the whole matter, and he has also been so good as to allow me to communicate to the readers of NATURE the substance of what he has told me.

"The Tamia-caspi, or rain-tree of the Eastern Peruvian Andes, is not a myth, but a fact, although not exactly in the way popular rumour has lately presented it. I did not know there was any doubt as to the true origin of the 'rain.' I first witnessed the phenomenon in September 1855, when residing at Tarapoto (lat. 6½° S., long., 76° 20′, W.), a town or large village a few days eastward of Moyobamba, and little more than 1,000 feet above the sea level. I had gone one morning at daybreak, with two assistants, into the adjacent wooded hills to botanise. . . . . A little after seven o'clock, we came under a

lowish spreading tree, from which with a perfectly clear sky overhead a smart rain was falling. A glance upwards showed a multitude of cicadas sucking the juices of the tender young branches and leaves, and squirting forth slender streams of limpid fluid. We had barely time to note this when we were assailed by swarms of large black ants, which bit and stung fiercely, and obliged us to beat a retreat, my companions calling out as they ran 'Tamia-Caspi! Tamia-Caspi!' When we had shaken off our assailants, I ventured to approach the spot so near as to make out that the ants were greedily licking up the fluid as it fell. . . .

"My two Peruvians were already familiar with the phenomenon, and they knew very well that almost any tree, when in a state to afford food to the nearly omnivorous cicada, might become (*pro tem*) a Tamia-caspi, or rain-tree. This particular tree was evidently, from its foliage, an *Acacia*, but as I never saw it in flower or fruit, I cannot say of what species. I came on cicadas, similarly occupied, a few times afterwards, and on trees of very different kinds, but never without the pugnacious ants on the ground beneath. Among the trees on which I have seen cicadas feed, is one closely allied to the acacias, the beautiful *Pithecolobium saman*. The young branches are very succulent, and they bear elegant bipinnate leaves. . . . The pods are greedily eaten by deer and cattle. Another leguminous tree visited by cicadas is *Andira inermis*, and there are many more of the same and other families which I cannot specify. Perhaps they avoid only such as have poisonous or strongly resinous juices; and those which are permanently tenanted by ferocious ants such as all *Polygoneæ*, the leguminous *Platymiscium*, and a few others. . . . These ants rarely leave the tree which affords them food and shelter, and they jealously repel all intruders, the slightest scratch on the smooth bark sufficing to call their sentinels to the spot. They are quite distinct from the robust marauding ants that drink the cicadas' ejectamenta.

"I have no doubt you have above the true explanation of the Tamia-caspi, or rain-tree. As to the drip from a tree causing a little bog to form underneath and around it, that is a very common circumstance in various parts of the Amazon

Valley, in flats and hollows, wherever there is a thin covering of humus, or a non-absorbent sub-soil, and the crown of foliage is so dense as to greatly impede evaporation beneath it. On such sites the Achuál palm (*Mauritia flexuosa*), common enough between Moyobamba and Tarapoto, as well as on the savannahs of the Orinoco, and in subriparial forests of the Amazons affords a striking example of this property, as has already been remarked by Gumilla, Velasco, Humboldt, and others. Finally, although I never heard the name Tamia-Caspi applied to any particular kind of tree, during a residence of two years in the region where it is now said to be a speciality, it is quite possible that in the space of twenty-one years that have elapsed since I left Eastern Peru, that name may have been given to some tree with a greater drip than ordinary; but I expect the cicada will still be found responsible for 'the moisture pouring from the leaves and branches in an abundant shower'—the same as it was in my time."

Mr. Spruce's notes are so precise and careful that there is little difficulty in accepting his explanation of the rain-tree. It is, however, hard to understand the omission of all insect agency in the equally careful account given by Prof. Ernst, who attributes the "rain" to secretion from glands on the foot-stalk of the leaf on which drops of liquid are found, which are rapidly renewed on being removed with blotting paper. It is curious that precisely the same question has been the subject of controversy in the Old World with respect to honey-dew. It is generally believed that this is the result of the aggregate ejecta of Aphides feeding on the juices of the lime. So com petent an observer, however, as Boussingault was of opinion that honey-dew was a spontaneous exudation, and it seems not impossible that the lime, as well as the *Pithecolobium saman* may, under some abnormal circumstances, exude a sugary secretion which insects would eagerly feed on.*—*Nature, No.* 435, *February* 1878.

W. T. THISELTON DYER.

* I have translated Boussingault's paper, and collected the evidence on both sides, in the *Journal* of the Royal Horticultural Society, new series, vol. iv., pp. 1-7.

South Australian Eucalypts.

TO THE EDITOR OF "THE INDIAN FORESTER."

DEAR SIR,—Sir Joseph Hooker has sent me a report by Dr. R. Schomburgk, the Director of the Botanic Gardens at Adelaide in South Australia, relative to the economic value of the various species of South Australian *Eucalypts.* The Species mentioned in this report are, it should be remembered, all natives of a temperate climate. They cannot be expected to thrive in the tropical districts of India, nor in the plains of North India, but the wonderful success of several temperate species of this genus on the Nilgiris and at Abbottabad in Hazara, justifies the expectation that some of the species here described will thrive at suitable elevations in the North West Himalaya and the mountains of South India. Nearly all the species of *Eucalyptus* hitherto introduced in India, have proved to be extremely rapid growers. Rapid growth is in fact their chief recommendation; but it is a very important recommendation; and should it ever be decided to take efficient steps for the production of fuel for the military stations of Kussowlie, Subathu and Dugshaie in the North West Himalaya, some of the temperate species of *Eucalyptus* will probably be found useful.

The following is Dr. Schomburgk's report:—

REPORT RELATIVE TO THE ECONOMICAL VALUE OF THE VARIOUS SPECIES OF SOUTH AUSTRALIAN "EUCALYPTS."

The preponderance of the great genus of Australia, *viz.*, the *Eucalypts*, also prevails over the whole area of South Australia, but with a deficiency in species in comparison with those of the east, north, and west flora. The number of species of *Eucalyptus* known at present in Australia is about 134: of these only 30 species appear in the extra-tropical part of South Australia.

The South Australian *Eucalypts* do not reach so great a height as those of the east, north, and west—the average that our tallest trees obtain being from 120 to 130 feet, with a stem of from six to eight feet in diameter; and such trees are only found in districts favored by good soil, or on the banks of rivers.

But these heights sink into insignificance compared with *Eucalypts* indigenous to Victoria, Tasmania, and Western Australia.

Amongst the thirty species of *Eucalypts* appearing in the extra-tropical part of South Australia, there are only about ten kinds whose timber is much valued and used. But I think this is far from being a complete enumeration of all the valuable *Eucalypts.* The greatest part of central South Australia, containing only a population engaged in pastoral pursuits, who have no other use for timber than the erection of roughly-made buildings, fences, &c., therefore many species of the *Eucalypts,* which appear in the interior, may possess even more valuable timber than those near the coast.

The most known valuable *Eucalypts* are distinguished by certain colonial names—such as Red, White, Blue, and Swamp Gum, Stringybark, Peppermint, Ironbark, Mallee, &c. But in the neighbouring colonies different popular names designate the same species of *Eucalyptus.*

THE RED GUM—*Eucalyptus rostrata* (Schlecht).—A very large tree, attaining from 100 to 130 feet.	Considered the most valuable timber of the Colony. Has a very close grain, and is hard and durable; the best wood for underground work, bridges, jetties, railway sleepers, and shipbuilding, and possessing the important property that the wood is not attacked by white ants. It is the most durable of all the woods of South Australia.
THE WHITE GUM—*Eucalyptus Stuartiana* (F. Muell.)—A large tree.	The wood is not so hard and close-grained as that of the Red Gum. It is used for posts, rails, building purposes, and underground work.
THE BLUE GUM—*Eucalyptus viminalis* (Labil.)—A tree of moderate size.	Hard and valuable timber—highly prized for its hardness, toughness, and durability. Used for wheel-wright work—*viz.,* naves and felloes.

THE STRINGY-BARK—*Eucalyptus obliqua* (L'Herit.)—An immense tree, attaining a height from 120 to 140 feet.	Is much valued in regard to its free splitting quality; the best for shingles, rails, and roof work, but not adapted for underground work.
THE PEPPERMINT—*Eucalyptus odorata* (Behr.)—A tree of medium size.	The wood *is only used for* fencing purposes and firewood.
THE IRONBARK—*Eucalyptus leucoxylon* (F. Muell.)—A middle-sized tree.	A very hard and durable timber, used for building and fencing purposes.
THE BOX TREE—*Eucalyptus hemiphloia* (F. Muell.)—A small tree.	A strong durable timber for hardness and toughness.
THE BASTARD BOX—*Eucalyptus gracilis* (F. Muell.)—A small tree.	Used for various purposes. Famous for hardness and toughness.
THE MALLEE—*Eucalyptus dumosa* (A. Cunn.)—A small tree, or arborescent shrub.	Very hard and close-grained; also famous for toughness. Used mostly for fencing stuff.
THE SWAMP GUM—*Eucalyptus siderophloia* (Benth.)—A large tree.	The timber very durable; used largely for building and fencing purposes.

But beside the useful timber of the *Eucalypts*, they possess also other valuable properties. The antifebrile quality of these useful trees is pretty well known abroad.

A valuable *acetic acid* is produced from *Eucalypts obliqua, E. leucoxylon*, and *E. rostrata ; wood spirit* from the wood of *Eucalyptus leucoxylon* and *E. obliqua ; essential oil* is produced from the leaves of *Eucalyptus viminalis, E. Stuartiana,* and *E. citriodora ; tar* from the wood of *Eucalyptus rostrata, E. leucoxylon*, and *E. obliqua ; paper* (a very fair sample) is obtained from the bark of *Eucalyptus Stuartiana, E. obliqua, E. rostrata, E. leucoxylon.*

R. SCHOMBURGK, *Director.*

Eucalyptus in Algeria.

SUPPLEMENTARY REPORT BY LIEUTENANT-COLONEL R. L. PLAYFAIR, CONSUL-GENERAL AT ALGIERS, ON THE CULTIVATION OF EUCALYPTUS IN ALGERIA.

In the report of my journey to Tunis last year, I stated my conviction and I endeavoured to prove that the principal cause of the decadence of that country and of the exhaustion of its soil, was the destruction of its forests, which has been going on ever since the Arab conquest, and more especially during the past hundred years. Since then I have given much consideration to the question of the *reboisement* of Algeria; especially as to whether this process, so conducive to the public good, could not be made one of advantage to the individual speculator. When duty and profit can be made coincident, it is wonderful how easy the former becomes.

For this purpose I determined to visit leisurely the whole of the plains of the Metidja and the Chelif, in which, if anywhere, suitable land might be found. I read everything that has been written on the subject of Australian trees, and I purpose now to record, not only the result of my own observations, but the opinions of those far better qualified than I am, as to the best means of restoring to Algeria the forests which were formerly the cause of its great agricultural wealth, and of opening out a means of employment for superfluous capital and energy.

The most interesting papers which have been written on the subject, and to which I more particularly allude, are :—

1. Rôle de l'Eucalyptus en Algérie, par M. Trottier, 1876; and

2. L'Eucalyptus au point de vue de l'Hygiène en Algérie, par le Dr. E. L. Bertherand, 1876.

Effects of the destruction of forests on the climate of Algeria.—The same causes, which have been at work in Tunis, have produced similar results, though in a less degree, in Algeria. In the latter country the destruction of the forests

has been less complete, therefore the country has remained more fertile, but the climate is changing in an appreciable degree every year.

Tolerably correct meteorological observations exist at Algiers since 1838. If we divide this lapse of time into three periods, we find the annual rainfall as follows* :—

			Millimetres.
1st period of 12 years	...	...	800
2nd „ „ 12 „	...	...	770
3rd „ „ 14 „	...	...	639

There can be no doubt as to the cause of this decrease. At the period of the conquest the whole of the Sahel, and a great part of the Metidja, was covered with wood or scrub, which acted not only as a parasol to the earth, preventing the undue evaporation of its dampness, but as a means of attracting and condensing the moisture in the atmosphere, and causing it to descend in refreshing dews or rain.

The first serious clearings in this district were made in 1845, since which time the operation has been going on with ever-increasing rapidity. The diminution in the rainfall commenced in 1855. In the seventeen years prior to this date, it was only on two occasions more than 1,000 millimetres, and on eight occasions more than 800. In the twenty-one years which follow, it has only twice reached 800 millimetres, and the present year is almost the worst of all, and something very like famine is imminent in Western Algeria.

Reboisement of Algeria by Australian trees.—The question not only of restoring to the country the wood that it has lost, but of providing a supply of a constantly decreasing article, is the most important one that can engage the attention of the statesman or the colonist. If this had to be effected by planting such trees as oak, ash, pine, &c., all of which are indigenous to the country, it may well be imagined that a speculator would hesitate about engaging his capital in an enterprise which could hardly yield him a return in his lifetime;

* I need hardly apologize for using the French metric system, which is so much more rational than the English one. The reader need only recollect that a hectare is equal to 2½ acres, a pound to 25 francs, and a metre to 3⅓ feet.

but with Australian trees, which grow as freely in Algeria as in their native country, he may expect to cover his expenses in ten or twelve years, and after twenty or twenty-five to obtain as great results as could be realized by oak forests of a century's growth.

It is hardly more than fifteen years since the first Eucalyptus trees were introduced into Algeria by M. Ramel, and very few indeed exist in the colony of a greater age than ten years; even now it can hardly be said that any attempt has been made to grow them on a great scale.

In the following remarks I intend to confine myself exclusively to the Eucalyptus. There are many other Australian trees suited to almost every condition of soil found in this colony, such as the beautiful *Acacias* or wattles, the *Grevillea*, *Casuarinas*, &c.; these are no doubt destined to play an important part in the *reboisement* of the country, but it is the Eucalyptus alone which merits to be planted over extensive areas for the sake of its timber.

There may be parts of Europe where this tree could be cultivated as well as in Algeria, though that is very doubtful, but hardly anywhere is the price of land sufficiently moderate to enable it to be grown with a certainty of profit.

As a rule, wherever the orange tree flourishes, so does the Eucalyptus. In Algeria it attains in six or seven years the same dimensions as the oak does in twenty, and in its twentieth year it may be expected to furnish such logs of timber for shipbuilding or other purposes as could not be furnished by an oak tree under 100 years old.

Quality and density of Eucalyptus timber.—There are trees which even in Europe, under certain circumstances, grow with great rapidity; but the marvel is that, growing with the rapidity it does, the Eucalyptus should produce at the same time hard and dense timber. A short time ago, wishing to send a Eucalyptus tree of four or five years of age to England for experiment, it was found impossible, on account of its great length, to put it into a boat to convey it to the steamer. The boatman naturally decided on towing it alongside, but the moment he put it into the sea, it sank to the bot-

tom, and divers had to be employed to raise it. When properly seasoned its specific gravity becomes less, and it then floats on water.

To illustrate the quality of the timber, I may instance the case of a vessel, the "Marie," of 230 tons burden, which entered the port of Algiers with a cargo of timber in 1875. It was built in Melbourne in 1848, the hull being of blue gum (*Eucalyptus globulus*), and the interior fittings of red gum (*Eucalyptus resinifera*). At 27 years of age it was still rated by the *Bureau Veritas* as of the first class.

Rate of growth.—The first trees ever planted in Algeria were sown in 1862. The following table shows the dimensions of these and of others planted subsequently, taken in September 1874, by M. Trottier :—

Year in which planted.	Age of trees in 1874.	Circumference at one metre from the ground.	Where grown.
	Years.	Metres.	
1862	12	1·52	Jardin d'Essai, upper part.
1863	11	1·42	" "
1864	10	1·28	" road side.
1867	7	0·90	M. Trottier's, Hussein-Dey.
1871	3	0·30	Maison Carrée.

These results were obtained not under the most favourable circumstances. During the last few days I measured one, planted in deep and fresh alluvial soil, nine years of age, and 1·57 metres in circumference, about six inches more than I could embrace with both arms. In Australia the mean height of very old trees is said to be between 60 and 70 metres, and their mean circumference from 6 to 8 metres.

Pecuniary results of plantation.—M. Trottier gives the following as the pecuniary results he thinks obtainable from a hectare of land planted with Eucalyptus :—

Age of trees.	Length of trunk.	Mean circumference.	Price per cubic metre.	Value of the cut.	Employment of timber.
Years.	Metres.	Metres.	Francs.	Francs.	
3	5	0·20	...	·500	As staves.
6	8	0·75	20	3·120	Carpentry, telegraph posts, &c.
10	9	1·30	30	7·140	*Railway sleepers.*
15	10	1·85	40	12·160	Large timber.
20	12	2·30	50	27·900	" "

Thus a plantation of one hectare, which gives appreciable results in the third year, will yield in the tenth a minimum of 7,000 francs, and in double the time it ought to produce four times the value. This estimate may be exaggerated, but even allowing a liberal margin for pardonable enthusiasm, the result cannot fail to be most remunerative.

But to arrive at the best results with Eucalyptus they must be planted in the best land, and for the first years at least be carefully cultivated. Thus treated, they may be expected to realize immense returns. For instance, the average yield of a hectare planted in cereals in Algeria may be estimated at 250 francs, and without taking any account of the years when such land must of necessity remain fallow, the total produce in twenty years may be stated at 5,000 francs.

During those twenty years the cost of cultivation, the value of the seed, the transport to market, &c., may be considered as equivalent to the cost of planting the same area in Eucalyptus, tending the trees and finally cutting them down. According to the preceding table the timber would then have a value of 27,900 francs; or, for the sake of being well within the mark, say 20,000 francs. If the cultivator has to remain a long time without any return for his money, surely the result is worth waiting for.

Effect of increased care in cultivation.—The time during which these trees occupy the soil may be divided into two periods of ten years each—the first the period of growth, the second the period during which the ligneous products are condensed and consolidated.

If during the first period the land is kept clear and the same amount of culture is given to the trees as would be given to a vineyard, the cost, calculating 5 per cent. interest on the sums successively expended, might amount in round numbers to 1,000 francs. During the second period no care of any kind would be required. Under the circumstances there is every reason to suppose that the trees would make as much progress in twenty years as they otherwise would in thirty. The cost of this extra care would amount to 1,000 francs, and the profit to 13,000 francs.

Comparison between Oak and Eucalyptus.—According to the tables of Cotta, a hectare of land produces 450 cubic metres of oak in 100 years, the value of which at 105 francs the metre amounts to 47,235 francs.

The same quantity of Eucalyptus wood might be produced in twenty years and would realize 20,000 francs. This sum of money, placed at compound interest from 20 to 100 years, would give the enormous sum of 816,800 francs.

Danger of fire.—No doubt that with so highly inflammable a substance as Eucalyptus wood, and with leaves so rich in essential oil, the risk of fire is a matter to be taken into serious account. It cannot, however, be much greater than in a pine forest; and the danger may to some extent be guarded against by planting the land in blocks of ten hectares each, and leaving a wide space between them which may be utilized either for the cultivation of cereals or as pasture land.

In the case of a pine forest catching fire, the destruction to the trees is absolute. Eucalyptus, though checked in its growth for the time, sends out fresh shoots in many cases.

Species of Eucalyptus.—The number of species of Eucalyptus is infinite, but for the purposes of commerce two or perhaps three species only should be cultivated. The first, the *Eucalyptus globulus*, or blue gum, is best suited to warm positions, deep, fresh and moist soil. The second *Eucalyptus resinifera*, or red gum, resists drought in a remarkable manner, and should be used in poorer or drier soil, or at greater altitudes than the other. It is hardly probable, however, that either of them will thrive well at a greater altitude than 200 or 300 metres above the level of the sea. The third species, which promises well, is the *Eucalyptus colossea*, but hitherto our experience of it is limited, and we have not sufficient data on which to calculate its rate of growth.

Sanitary effects of Eucalyptus.—There is another point of view from which the cultivation of Eucalyptus must be regarded, namely, its action in improving the sanitary condition of unhealthy districts, and in dissipating miasmatic influences, which created such havoc amongst the colonists in the first years after the conquest.

To place this subject as far as possible beyond doubt, an inquiry was instituted by the Society of Physical and Natural Sciences at Algiers, under the presidency of Dr. Bertherand, and reports were received from thirty localities, extracts from a very few of which only are here given.

Eucalyptus at Lake Fetzara.—In 1869, 60,000 young trees of *Eucalyptus globulus* were planted on the banks of Lake Fetzara, near Bone: now they have attained the height of 7 or 8 metres each, and have produced a very marked effect on the locality.

Such was the feverish condition of this district on the annual fall of the water and the denudation of its banks, that the Director of the Jardin d' Essai, who went to examine the condition of the plants, was immediately seized with a violent fever which lasted twenty days. That same gentleman now reports that the miasmatic influences which affected him so strongly there have disappeared, and the mosquitoes which rendered the place uninhabitable have disappeared with them.

Eucalyptus at Mokta el-Hadid.—Formerly it was impossible for the workmen at the great iron mines of Mokta el-Hadid to remain there during summer; those who attempted to do so died, and the company was obliged to take the labourers to the mines by train every morning, and to carry them back to Bone every night, a distance of 33 kilometres each way. From 1868 to 1870 the company planted more than 100,000 Eucalyptus, and now the workmen are able to live all the year through on the scene of their labour. The entire works and the railway leading to them are bordered with thick belts of these trees, and each of the miners has his cottage and kitchen garden surrounded with them.

Eucalyptus at the Mason Carée.—At the mill of St. Corinne, belonging to the late M. Saulière, at the Maison Carée, near Algiers, a marsh situated to the south of it rendered the place uninhabitable at certain seasons of the year.

M. Saulière, in despair at having to renew his workmen very two months, called in the services of Dr. Payn, begged him to visit the place regularly, and placed liberally at his disposal every remedial agent that he could suggest. Dr.

Payn proposed that the marsh should be planted with Eucalyptus. In two years these trees attained a gigantic size, and fever almost entirely disappeared.

Method by which Eucalyptus improves climate.—It is unnecessary to multiply instances; almost every one of the thirty competent persons interrogated bore testimony to the fact that the introduction of this tree had exercised a salutary influence on the health of the district.

In some places the trees destroyed miasma by utilizing the moisture of the soil in which they were planted and thus draining marshes. The emanations from their leaves also may have produced a salutary effect. They contain a large quantity of essential oil very similar to turpentine, which they emit in great quantities, especially when stirred by the wind, and this acts, it is supposed, as a febrifuge.

Localities suited for the growth of Eucalyptus.—There is another subject worthy of consideration—the localities best suited to the growth of the plant on a large scale, and the price of land available for the purpose.

To ensure the commercial success of the scheme, the trees must be planted on a line of railway and as close as possible to a station. The soil ought to be rich and deep, and there ought to be sufficient water available for irrigating the trees during the first year, not frequently, but once when they are planted in autumn, and twice or thrice during course of the subsequent summer. They will grow in the driest soil, but their growth is infinitely more rapid when planted under the above conditions.

Plain of Metidja.—There is no doubt that the locality which fulfils these conditions best is the plain of the Metidja. Between Algiers and Blidah, on the line of rail, it is hardly possible to obtain land for less than 500 to 700 francs the hectare; some has recently been sold for 1,000 francs. Further from the railway it may be had in some few places for 300 francs, but the cost of transport would neutralize the saving.

Plains of the Chelif and Mina.—In the plains of the Chelif and the Mina there is an enormous quantity of land which

may still be obtained for a merely nominal price. It would be an immense boon to the country if some of this were planted with Eucalyptus, but the chances of profit to the cultivator would not be so certain. The soil is hardly inferior to that of the Mètidja, but the hydrometrical conditions of its climate are very different. The range of hills stretching westward from Miliana cuts it off from the sea breezes, which always afford a certain quantity of moisture; rain is more scarce, and the farmer can hardly hope for more than one good year out of three. From Affreville, where it commences, to Oran, is a distance of about 300 kilometres. It is traversed by the most important river in Algeria, the Chelif, which rises in the Sahara and falls into the sea near Mostaganem.

Barrage of the Chelif.—A barrage has been built near Orleansville, and it is possible that there may be good irrigable land procurable in that locality, but as it is the only part of the plain which I did not carefully inspect, and the only irrigational work that I did not see, I cannot speak positively on the subject. I have been assured, however, by the Government of Algeria that from 2,000 to 3,000 hectares of land, situated between the Oued Ouran and the Oued Ras, irrigable by the barrage of the Chelif, might be found there well suited for the purpose.

Barrage of La Djidiouia.—The most important barrages are in the valleys on the south side of the river, at Lat Djidiouia 263 kilometres from Algiers; a magnificent dam of cut-stone and hydraulic cement has been built across a gorge in the course of the river, thus forming a lake containing 2,000,000 cubic metres of water.

Barrage of the Mina.—At Relizane there is a barrage of another nature; at a spot where the river Mina leaves the level plain in which it has hitherto flowed to enter by a series of rapids a lower rocky bed, a dyke has been constructed to raise its level and to divert the water into canals on either side for the irrigation of the country around.

Barrage of tha Oued Ferzoug.—The finest of all, however, is the barrage of the Oued Ferzoug, near Perregaux, 346 kilometres from Algiers, and 76 kilometres from Oran. This

work, as well as the railway now being constructed between Arzew and Saïda, is due to the private enterprise of M. Debrousse, who has received no guarantee of interest, but a concession of 24,000 hectares of irrigable land between Perregaux and the sea, most of which is at present unreclaimed, either in the state of tamarisk forest or of pestilential swamp.

The barrage is situated at the junction of three rivers; it measures 500 metres in length and contains the enormous quantity of 32,000,000 cubic metres of water. I need not allude to the other works of a similar nature; I only wish to show that, dry as the plain of the Chelif and the Mina is, there are not wanting considerable tracts of land capable of artificial irrigation.

Price of land in the plain of the Chelif.—The price of land is nowhere high; almost any quantity can be purchased at 50 or 60 francs a hectare, and I was shown beautiful land, cleared and irrigable, which might be had at 100 francs.

One property particularly struck me; it consisted of 600 hectares. One side was bounded by the river Chelif, the other by the Dahra, the range of hills along its right bank. A part of it was watered by a stream descending from those mountains, and I saw on the opposite bank of the river an artesian well which brought water to the surface of the ground, from which I inferred that the same thing might be practicable on the property to which I allude. It was traversed by a high road, and a bridge across the river was about to be constructed; an important Arab market took place on the land every week, and in addition it had a large dwelling house, which was, however, much out of repair; with all these advantages the property was for sale for 60,000 francs (2,400*l*).

Considerable numbers of Eucalyptus have deen planted all along the line of railway from Algiers to Oran. Where this line passes through the Metidja the trees have grown most successfully, but in the Chelif they have failed in almost every case. It is true that they have not been tended in any way; they have merely been planted and left to their fate.

In and around villages in this plain they have thriven better, but still never so well as in the Metidja, while in the marshy

plain of the Macta, conceded to M. Debrousse, which at first sight appears a typical position for them, they have not done well at all. The reason for this is, that the land is not yet ready for them; it has lain in a state of marsh for centuries, the sub-soil is saturated with salt, and the more the trees are watered after being planted the sooner the capillary attraction brings the salt to the surface and kills the trees or checks their growth.

Land in Province of Constantine.—These remarks appply only to the two great plains over which I have travelled this year: there are no doubt localities as good situated elsewhere, especially in the plain of Bône and on the line of railway now being constructed to Guelma. I cannot speak with any certainty of the price of such, but regarding its suitability for the growth of Eucalyptus there can be no doubt.

On a careful consideration of the whole subject, I feel more convinced than ever that no culture in Algeria offers such prospects of success as Eucalyptus, if the cultivator can afford to remain for a considerable time without any return for his capital, that in the long run it will be more economical to purchase land for the purpose at 600 francs a hectare than at 60 francs, but that to ensure success the experiment should be made close to a line of railway and in a comparatively cool and salubrious position.

Eucalyptus at Abbottabad.

In 1866 a large number of trees were planted at the station of Abbottabad in the Punjab hills. We hear, on the authority of the medical officer of the 5th Goorkhas now stationed there, that many of the trees have already reached the height of 100 feet, which must be looked upon as the most successful attempt yet made towards the acclimatization of the Eucalyptus. The same officer considers that the salubrity and immunity from fever enjoyed of late years at Abbottabad may be partly due to the introduction of these trees.

A new property of Eucalyptus.

In "Nature" for November 8th, 1877 (No. 419, Vol. 17) we read that from statements made at a meeting of the Californian Academy of Sciences, the eucalyptus tree may be enumerated among the means for checking fire. Eucalyptus shingles are said to be fire-proof. A tree of this species was exposed to the San Francisco fire of 1876 and is still flourishing. The notion is urged that the spread of fire in cities could be checked by setting out such trees for shade and ornament. All varieties of the eucalyptus are said to possess this valuable property.

B. H. B. P.

Eucalyptus and other Australian Timbers.

We are glad to notice a valuable contribution to the literature of the Eucalyptus, a carefully written paper in the Roorkee series.*

Mr. McKinney has recently spent some months in Australia and devoted himself to an examination of Colonial timber, especially as to the confusion which exists in regard to names; for almost all sawn Colonial wood is called *blue gum* in virtue of the good qualities of an article which at Victoria is an imported product, and which is rare even in its original habitat. Mr. McKinney set himself to find out what the timbers really were, and what their actual strength and value as materials apart from popular rumours and current notices based on no solid information.

We extract the following interesting account of the chief *Eucalypti* of Victoria and New South Wales:—

"In Victoria four-fifths of the trees belong to the genus *eucalyptus*, of which, on the authority of Hooker, there are said to be no less than fifty-five varieties in that colony and New South Wales. In both colonies the most important of these is the *red gum*. It grows to a height of from 80 to 120 feet, with a diameter of from 3 to 5 feet, and furnishes a hard, reddish-coloured wood, of specific gravity 1·12. It is remarkably durable in damp ground and in water, whether salt or fresh, and it shrinks less longitudinally than almost any other of the *eucalypti*. On the other hand it has a short and somewhat wavy grain, which renders it unsafe for beams or for other purposes where horizontal bearing timbers are required. Its great durability in water and in damp ground, and the resistance it affords to the attacks of the teredo, render red gum most valuable for piles for engineering works. It is also highly prized for sleepers and for the planking of bridges, wharves, &c. The available supply of red gum is enormous, as forests of it extend for hundreds of miles along the banks of the four great rivers of New South Wales, and of the auxiliary branches and creeks connected with those rivers. The red gum on the Lachlan and Darling is, it should be remarked, stunted, and of inferior quality to that on the other rivers.

* Professional Papers, 2nd. Series, No. CCXXXVI, Useful Australasian Timbers, by H. G. McKinney, Esq., Asst. Engineer, North Division, Ganges Canal.

"The *ironbark* was formerly found in abundance on the hilly and undulating districts of Victoria and New South Wales, but the available supply of it is rapidly diminishing. It attains its greatest size in the eastern parts of New South Wales, where it is sometimes found 150 feet in height. It furnishes a hard reddish coloured timber, of specific gravity 1·14, which bears a close resemblance to jarrah and red gum, is extremely durable, and is one of the strongest timbers in the world.

"*Stringy bark* is a tree which supplies much of the second class timber in the Australian market, and much of that too which is sold as blue gum. The stringy bark of Tasmania seems to be much superior to that of New South Wales and Victoria. In the latter colonies its tendency to twist or warp, and its liability to destruction from dry rot, have procured for it the reputation of unfitness for use in construction. The readiness with which it splits has, however, induced its use on a large scale for posts and rails for fences. The stringy bark of Tasmania has been used to some extent in ship building, and piles of this timber in the wharves at Hobart Town have endured for many years, and are still in an excellent state of preservation. It seems not improbable that if properly seasoned, there would be little reason to complain of its warping. Stringy bark timber can be had in very large pieces; it is hard, straight-grained and durable, and its specific gravity is slightly less than unity. Although it is very difficult to distinguish this timber from blue gum, the difference between the trees is at once apparent. The bark of the former is rough and fibrous, resembling to a considerable degree the husk of a cocoanut, and its leaves are always similar to those of the mature blue gum but smaller in size.

"*Peppermint* is another of the eucalypti which is found abundantly in both Australia and Tasmania. It is sometimes confounded with stringy bark, though there are decided differences, the leaves of the former being much smaller than those of the latter, and its bark being much more like that of blue gum. The peppermint grows in different localities to heights varying from 80 to 200 feet. The timber obtained from it is similar in character, but inferior to stringy bark.

"At least seven different varieties of eucalyptus are known as *box*, being locally distinguished as "yellow" box, "swamp" box, &c. The different varieties of box are generally found on plains at a

distance from the rivers, occupying along the courses of the minor creeks, the place which red gum takes on the rivers and larger creeks, and they grow to heights generally varying from 40 to 60 feet."

Of the Tasmanian trees Mr. McKinney deals chiefly with blue gum, properly so called (*E. globulus*), and his conclusions as to its cultivation are just what have been recently, but only recently, arrived at in India. It is not Mr. McKinney's object to treat the subject of *Eucalypti* from a cultural point of view; and, therefore, it was no part of his duty to distinguish for us each one of the species he has named, as to whether it grows in temperate or tropical, in wet or dry, localities. He says :—

"The only Tasmanian tree which I propose to describe is the blue gum or *Eucalyptus globulus*. This is a tree which has attracted an extraordinary amount of attention, and to which have been ascribed almost all the virtues of all the eucalypti, as well as some properties to which none of them has a claim. We have seen that a Committee of Victorians call it an *imported* tree, and I have looked in vain for its name in catalogues of the valuable trees of the other Australian colonies. Hence it is quite an error to term it "the Australian blue gum." Tasmania, the native land of the Eucalyptus globulus, possesses a very temperate climate, and though it has some extensive plains, is essentially a hilly country. Not only is the blue gum generally found on the mountains and hilly ground, but it has been ascertained that the trees grown in valleys or ravines furnish timber of inferior quality to that from the mountains. Yet the eucalyptus globulus is popularly described as a tree which is remarkably suited for planting in marshy plains in tropical and semi-tropical climates. The explanation of this extraordinary fallacy is no doubt to be found in the statement made by the Victorian Committee, that the name "blue gum" has been applied to nearly every variety of eucalyptus which supplied timber to the Australian market. Again the medicinal properties of the blue gum are much overrated, although it is beyond question that it and several others of the eucalypti do possess such properties. The aborigines of New South Wales made known these properties to the colonists long ago, but the tree which chiefly supplied them with medicines was the *red gum*.

"It is not improbable that some of the Australasian trees which have been acclimatized in various countries as blue gum, are those

known in Victoria and Tasmania as swamp gum. As much controversy has taken place on this subject, and as the Tasmanian blue gum is one of the most easily recognized of the eucalypti, a description of it will not be out of place. The name of this tree is probably derived from the whitish blue colour of both the leaves and bark in the early stages of its growth. At this period the leaves are sessile and opposite, and are from 3 to 6 inches in length and from 2 to 3½ inches in breadth. They are round at the extremity, and have distinct upper and under surfaces. The duration of this series of leaves is uncertain, but is generally from two to six years. The second series of leaves begin to appear at the top of the tree and at the extremities of the branches, and the process of changing goes on sometimes for several years till all the leaves of the first series have been displaced. The second series of leaves is entirely different to the first, being petiolate, alternative, and pendulous. They are generally from 4 to 8 inches in length, and from 1 to 1½ inches in breadth, are tapering, curved downwards towards the point or apex, and, like the leaves of other eucalypti, hang vertically. To an ordinary observer the two sides of one of these leaves are precisely similar. When a tree is felled, or when any of the large branches are cut off, the shoots which spring from the stump have sessile leaves similar to those of young plants. The appearance of blue gum trees of from three to nine years of age or of old trees which have been dressed, is, therefore, most peculiar; the whitish-blue, rounded sessile leaves being a remarkable contrast to the dark green, pointed, pendulous ones. I had an opportunity of noticing numerous instances of the former near Hobart Town in Tasmania, and of the latter at Ballarat, where imported blue gums have been planted along the sides of the streets. After the disappearance of the sessile leaves, the blue gum seems to be continually shedding the outer layers of its bark. This generally gives the tree an untidy appearance, as the bark comes of, either in short curled pieces or in long shreds, which frequently hang loosely to the tree. When a strip of the outer layer of bark is peeled off, the surface exposed is of a bright buff colour, which, however, soon changes to grey. The timber of the blue gum is of a yellowish grey colour, of a close, straight grain, and has a specific gravity of 1·05. As the tree grows to an enormous height, the timber can be had in very large pieces. It has a first class reputation, notwithstanding the fact, that it has generally been cut at a bad time

of the year, and used without being preperly seasoned. It has the disadvantage of being readily attacked by the teredo.

"The trees which have been mentioned, include the best known and most valued of the eucalypti in Victoria and New South Wales. Besides these, there are some varieties which will yet attract much attention. In an official publication of the former colony, it is stated that a specimen of the *Eucalyptus amygdalina* was found in one of the mountain ranges in a north-easterly direct tion from Melbourne, which proved to be 480 feet in height, and that another specimen measured 81 feet in circumference."

A notice of the cypress pine is worth reproducing:—

"Of the other trees indigenous to eastern and south-eastern Australia, probably the most important are the red cedar and the cypress pine. The former is found chiefly in the north-eastern districts of New South Wales and in Queensland. It grows to a height of 150 feet, and a diameter of 10 feet, and the wood in colour resembles mahogany, but its specific gravity is only 0·45. Owing to the enormous quantities of this timber which are exported from New South Wales, the supply is rapidly decreasing. It was estimated in 1871, that the export to Melbourne alone amounted to 100,000 superficial feet per week. Red cedar combines great lightness with durability and a fair amount of strength, and it is very easily worked.

"The cypress pine seldom grows to a height of more than from 50 to 70 feet, and a diameter of 1½ feet, and the timber obtained from it has only about half the value of red cedar. It is found in great abundance on sandy ridges and on low hills. As the cypress pine is perfectly straight, and is easily worked, it is used very extensively, and the export of it is equal to that of red cedar."

In another place the author mentions that in the plains of New South Wales sandy ridges are frequently met with, on which only a very scanty crop of grass grows, but where the cypress pine flourishes. It cannot, he says, be called a *first* class wood, but is straight, easily worked, and not readily attacked by white ants. This would appear to be a tropical species.

Mr. McKinney also remarks on the adaptability of the red gum which he says likes alluvial soil and the nearness of moisture, adding that the best grows on the Murray river,

in a climate subject to hot winds, and not unlike that of Northern India.

"The most important trees of Western Australia are the jarrah, the tewart or tuart, and the kari, all varieties of eucalyptus. Jarrah is found in great abundance on the so-called ironstone ranges. It is a hard, close-grained, dark-red wood, bearing considerable resemblance to red gum. It has obtained a very high reputation for strength and durability, and for resistance to the attacks of the white-ant and the teredo navalis. For these reasons it constitutes one of the most important of the exports of Western Australia, and considerable quantities of it have been sent to India for sleepers. The reputation of jarrah timber was seriously injured some years ago, on account of the export of large quantities of an inferior variety found in the plains; India being intended as one of the sufferers from the transaction. It was then clearly ascertained that jarrah timber of the best quality is found only on the mountain ranges."

On the subject of white ants the author writes:—

"I brought some specimens of colonial wood with me on my return to India, intending to ascertain to what extent they resist the attack of white ants, but have not had time yet to do more than make a ten days' trial. I may mention, however, that specimens of ironbark, red gum, cypress pine, jarrah, kauri, myrtle, blackwood and Huon* pine, after being buried for that period in a white ant's nest where the ants were present in multitudes, remained untouched. (The last three woods are Tasmanian, and the last two are much valued in cabinet-making.)"

In conclusion we reproduce Mr. McKinney's useful table of experiments.

* Called after the River Huon, where it is abundantly found.

EXPERIMENTS ON AUSTRALASIAN TIMBERS,

Showing the Transverse and Tensile Strength and the Elasticity, that of English Oak being unity.

Name.	Locality.	Specific gravity.		Relative Transverse Strength.	Order in Transverse Strength. A	Relative Tensile Strength.	Order in Tensile Strength. B	Relative Elasticity.	Order in Elasticity. C	REMARKS.
Ironbark ...	N. S. Wales	1·14	L.	1·745	2	1·106	7	2·165	7	The experiments bracketed and marked "L" are by the Timber Inspector to the Admiralty; those marked "SM" were carried out at the Sydney Mint. The columns marked "A," "B" and "C," show the order in which these timbers stood in a series of experiments on 42 of the best timbers obtainable.
Tuart ...	Western Australia.	1·17	L.	1·276	11	1·398	2	1·747	12	
Kari ...	Do.	0·98	L.	1·069	17	0·934	12	2·093	8	
Kauri ...	New Zealand	0·56	L.	0·892	29	0·600	23	1·622	17	
Blue gum ...	Tasmania	1·05	L.	0·883	30	0·798	18	1·750	11	
Jarrah ...	Western Australia.	1·01	L.	0·850	31	0·388	35	0·667	37	
Red gum ...	N. S. Wales	1·12	SM.	0·992	25 A			0·925	33 A	
Stringy-bark	Do.	0·98	SM.	0·933	28 A			0·892	35 A	
Peppermint	Do.	0·90	SM.	0·595	41 A			0·567	39 A	
Cypress pine	Do.	0·65	SM.	0·595	41 A			0·558	41 A	

These experiments were carried out chiefly at the Woolwich Dockyard.

The numbers to which "A" is attached show the order in which the timber experimented on at Sydney would have stood among those experimented on at Woolwich.

III. Notes and Queries.

Preparation of Bamboo Fibre for Paper-Making.

TO THE EDITOR OF THE "INDIAN FORESTER."

Dear Sir,—I have read with much interest in your last July number "The Report on the Preparation of Bamboo Fibre for Paper-Making by Mr. Smythies;" and, although I am glad to see the subject so far has commanded the attention I think it merits, I cannot but regret that the operations were carried out under such very disadvantageous conditions.

Were it attempted to manufacture bamboo stock in the manner pursued by Mr. Smythies, your editorial foot note would be fully warranted and endorsed by me, as most assuredly "Stock" so prepared would be unremunerative.

As these remarks, however, coupled to Mr. Smythies' report unless met and explained, are calculated to most prejudicially affect the future prospects of an important industry, to further which during the past two years I have devoted much careful investigation and practical experiment, I trust you will allow me space to discuss and reply to them, and at the same time to refer in detail to Mr. Smythies' report.

Although it may appear egotistical, I think I may say I am recognised in our English paper trade as an authority, more especially when raw fibres are concerned. It may be remarked that as pioneer and patentee of this new industry of bamboo paper stock, I am what may be termed "blowing the horn," but I am also largely interested in this question from a paper manufacturing point of view, seeing that at our works here we treat from 130 to 160 tons of esparto weekly, from which we produce 40 to 45 tons of fine printing papers, and convert the remaindar into half-stuff (pulp) and paper stock which we sell to other paper manufacturers both in this country and abroad; and as to-day prices for esparto rule high, and the quality is rapidly deteriorating, the introduction

of any new material suited for our trade is a subject becoming more and more important.

I believe bamboo to be that new material, its existence or production in India being practically unlimited; that excellent paper can be made from it is testified by the sheet on which I am now writing, and that on which my pamphlet is printed, the result of my first experiments; and I am satisfied that, under the system and by the process I propose, a manufactory for the preparation of paper stock favorably located to command a good supply of the raw material at reasonable rates, and near a port of shipment to economise carriage, would prove a most remunerative undertaking, as, allowing ample margin, the prepared stock could be laid down in England at from £17 to £18 per ton, and there can be no doubt it will meet with a ready sale in this or any other market, realising a good profit on the capital invested.

In giving comparative data in my pamphlet as to the prices and cost of other raw materials used in the paper trade, I have been careful to avoid exaggeration. At page 38 I refer to the value of the lowest description of esparto, *viz.*, African reduced to the same condition of "stock" as that to which I propose to prepare bamboo at £21 per ton; but I consider the latter, if properly treated, is superior even to Spanish esparto, say £25 per ton; and, as Mr. Smythies in his Report concludes that Rs. 100 may safely be taken "as the cost of turning out a ton of fibre," even with freight and other charges added, there is ample margin for profit.

Everything must have a beginning. In 1861 I was the only paper-maker using esparto: the importations this year will probably exceed 170,000 tons. In 1861 the imports of jute into England were about 50,000 tons; this year they will exceed 300,000 tons. Indigo, coffee, tea, flax, rice, and latterly corn, have tended to swell the exports and increase the material prosperity of India. I believe bamboo fibre will, in the future, assume an equally prominent position.

I will now refer to Mr. Smythies' Report, by which it appears his operations were commenced on the 31st August, and I therefore assume that the stems he treated were only about two

months' old. This is indeed indicated by their length and girth, although the latter may arise from a small variety of bamboo having been collected. I infer also that even from these stems a very considerable portion was removed (the 4 or 5 top internodes are mentioned); his dry yield moreover was only 10 per cent.

It is probable that stems only 12 feet long were taken, as in page 8 of my pamphlet (to which Mr. Smythies apparently refers) I mention that height; which however refers merely to the probable tonnage per acre, producible from a plantation.

From such extremely young stems the fibre would be very immature; they should have been allowed to grow till the conclusion of the rains, say October, when they would have attained probably a height of from 20 to 30 feet (the growth of the season in fact). The paper stock and paper I have made have been from stems from 20 to 26 feet long,—younger, the fibre is not sufficiently matured—older, it is too woody.

The ordinary native sugar rolls are simply useless for crushing. Crushing, indeed, is not all that is required; the stems must be passed through metal rolls, grooved or channelled, in order not merely to smash the knots or nodes, but to divide or split the stems into strips or ribands, which again must be cut across transversely before boiling, in order to admit free penetration and action of the alkaline ley.

The rolls also must travel at considerable speed and be driven for economy by steam power. One set properly arranged will pass through sufficient stems to keep a factory producing 60 tons of stock weekly fully supplied.

The pans used for boiling, only 18 inches deep, are correctly termed evaporating pans; the harder boiled the more evaporated, and the greater the waste of fuel. How indeed the bamboo stems were retained in these shallow pans while boiling is a puzzle to me. We use pans for boiling which contain one ton material constructed to economise fuel and avoid evaporation as much as possible.

I hardly know what to remark on the "crude soda from the bazars" used for the leys, but fancy it must have been potash, and probably in the state of carbonate, not caustic: if so, the

action on the bamboo would be nearly nil, and plain water almost as effectual.

Now of all the processes connected with paper-making, and more especially the treatment of raw fibres, the proper adjustment of the alkaline ley is the most critical, and technical knowledge is a "*sine quá non*:" too strong a dose being most injurious and wasteful; too weak a dose ineffectual. I therefore can readily understand how the fibre Mr. Smythies boiled, "was evidently in a less prepared state" than my specimen sent for comparison.

The attempt to dry bamboo or indeed any raw fibre when once disintegrated and reduced to the tow-like condition of stock by mere exposure to the weather is simply inadmissible; if for no other reason than the amount of dirt it would of necessity pick up; purity, cleanliness and entire freedom from grit being an absolute necessity. Contaminated indeed by any extraneous matter, the finest quality of fibre would be sadly deteriorated in value. The drying apparatus I have in operation here is both simple and economical in its action, and perfectly independent of the weather as dried, the stock is automatically removed to the hydraulic press and baled up for transport like cotton or jute.

I need hardly here refer to the questions of collection and carriage of the raw bamboo stems, as these points must be governed by local considerations; and will conclude this somewhat lengthy letter, trusting the day is not far distant when the English paper-maker may draw his supplies of material from our Indian Empire instead of as now being almost dependent on foreign countries.

I beg to remain,

DEAR SIR,

Yours faithfully,

THOS. ROUTLEDGE.

CLANHEUGH, NEAR SUNDERLAND,
The 25*th October* 1877.

Report on the Exotic Trees in the Fuel Plantations of the Nundidroog Division, Mysore.

No. 1688—170, *dated Bengalore, 29th October* 1877. *From the Conservator of Forests, Mysore and Coorg, to the Secretary to the Chief Commissioner of Mysore.*

I have the honour to submit a report on the number and condition of the exotics in the Nundidroog division fuel plantations. This report includes under the term "exotics" one species which is not indigenous to this part of the province, though it is abundant in Coorg and Western Mysore, and that is, *Nundee Lagerstrœmia Microcarpa.*

2. The various Australian trees referred to—the *Eucalypti, Acacia, Melanoxylon,* and *Wattle* or *Acacia dealbata*—have received no special care. Our object was to see whether or not they would thrive in the fuel plantations under the same treatment as other trees common to Eastern Mysore. They were therefore raised with others in nurseries, and put out into pots at the same time and received no watering, nor any more attention than did the indigenous trees.

3. The Carob (*Ceratonia siliqua*) was taken great care of. At this date there are but 54 living plants. Of these 30 are not more than 2 inches above ground, 20 but 6 inches, while four specimens have attained the height of, respectively, 2, 6, 6, and 10 feet. The first died down during the late droughts to 2 feet, but is now putting forth strong shoots and making good growth. All four are about eighteen months older than the smaller ones, which will, it is hoped, commence growing now.

4. There are seven mahogany trees, four of them being now 8 feet in height. These were raised from seed sown on the 7th June 1875. A quantity of seed which had been sown in prepared nursery beds had not germinated; 25 selected seeds were then soaked in camphor water (one ounce of camphor to a quart of water) for two hours, and sown in pots. Of these 25 seeds, 14 germinated—on the 9th day four, on the 10th day eight, and on the 12th day two. On 10th July two died, and on

the 4th August another died, the largest living plant being then $4\frac{1}{2}$ inches high. On the 16th September 1875 one was sent to Lall Bagh, and between that date and 1st October 1875 three more died. Four of the seven remaining trees were put out in October 1875 in large pits, and the other three put out in February 1876. All seven are still alive—one being 5 feet, two being 6 feet, and four being 8 feet in height, and all look well.

5. Since writing my report for 1876-77, three Red Saunder's seedlings have made their appearance in the nursery beds from long dormant seed (see paragraph 68 of Forest Report for 1875-76); they are prostrate, but look fresh and healthy.

6. I regret to state that we have now but four sâl seedlings left; they have been carefully tended, but with poor success.

7. There are 1,078 *Pinus longifolia* seedlings, all small, in the nurseries.

8. There are 118 *Nundee* seedlings and small trees, the tallest being 5 feet in height, and the smallest 2 feet, all looking well.

9. There are 191 *Wattle* trees (Australians), not counting the suckers thrown up; the tallest of these trees is 18 feet in height, and bulky in proportion. These wattles are seven years old. Many have thrown up suckers, and the parent trees flower and seed freely; but the number of suckers and growth of the trees is small compared with the luxuriant growth of the same tree on the Neilgherries. The tree yields good fuel, and seems to have established itself.

10. There are 790 *Eucalyptus robusta*, 74 *Eucalyptus globulus*, and 1 *Eucalyptus virgata*. The older of these trees are in their fifth year, the younger in their fourth year. Of the *robusta*, the tallest specimen is 35 feet in height; two measure 25 feet, two measure 18, and nineteen measure 15 feet. The remainder are below that, and some three hundred of them are but 3 feet and under.

Of the *globulus*, one is 40 feet, one measures 35 feet, one measures 30 feet; and of the remainder, two are 2 feet and the others between that and 21 feet. The solitary *virgata* is 30 feet. I have called this "virgata," it being identical in

appearance with two *Eucalypti* so called, which used to stand near the old monkey-house in the Lall Bagh. These trees were cut down two or three years ago, when the improvements were carried out in the gardens. The tallest *Eucalypti* owe their rapid growth, as compared with the others, to their being near water-courses or in richer land. Those in land with too much water lying on it have not done well. The tree seems, with us, to thrive best in a good loam with a liberal supply of running water not far off. It is, perhaps, early to pronounce on them yet, especially as they have had to go through two abnormally dry seasons. Of the three kinds (*robusta, globulus,* and *virgata*), 209 are 6 feet and upwards, and the larger specimens have flowered. If once well established, they would sell well as poles, if nothing else.

11. There are 26 *Acacia melanoxylon*, the tallest of which is 10 feet; three measure 8 feet, four measure 5 feet, and the rest are under that. They do not promise well.

12. There are other exotics in the Danaroydroog plantations, and a further report will be submitted on them after inspection. The state of the *Eucalypti* near Santawarri, in the Nagar division, was reported in my annual report for 1873-74. They will be again reported on hereafter. This report treats only of the exotics in the fuel plantations near Bangalore, and is compiled from Mr. Hutchins' inspection report made in the current month.

Abstract.

		Number.
Carob.—*Ceratonia siliqua*	... ...	54
Mahogany.—*Swietenia mahagoni*	... ...	7
Red Saunders.—(*Pterocarpus santalinus*)	...	3
Sâl.—(*Shorea robusta*) ...	... ...	4
Wattle.—(*Acacia dealbata*)	... ...	194
Gum trees.—*Eucalyptus robusta*	... ...	790
Gum trees.— „ *globulus*	... ...	74
Gum trees.— „ *virgata*	... ...	1
Australian Blackwood.—*Acacia melanoxylon*	...	26
TOTAL	...	1,153

The Origin of the Carbon in Plants.

Mr. J. W. Moll has made in Prof. Sach's Laboratory at Würzburg some researches on this subject during the summer of 1876. A detailed account of these, with the conclusions at which he has arrived, is promised in the *Landwirthschaftliche Tahrbücher von Nathusius und Thiel*, but a brief account will be found in the last number of the *Archives Néerlandaises*, tome xii., 4me livre. A plant with green-coloured cells can, under the influence of light, take the carbon it requires from the atmosphere, releasing, in the act of doing so, so much oxygen. This is a fact, too well vouched for by the experiments of Boussingault, Vogel, Rauwenhoff, and Harting, to admit of a doubt, but the quantity of carbon dioxide in our atmosphere is very small, and the quantity of carbon stored up during, say, a summer's growth in some large forest, is very great. Moreover, the roots of such plants are fixed in a soil which is highly charged with carbonaceous products, so the question quite naturally arises: May not the roots take up some of these atoms of carbon ready to their hand? Or may they not at least take up the carbon in the form of carbon dioxide, send this up the green granules in the leaves, and so give them a more abundant supply than they could get from the surrounding air? Besides, is it not a fact that most plants seem to thrive in a fine rich leaf mould, and may not its richness in carbon be partly the cause? One of the first questions Mr. Moll set himself to answer was: Can leaves decompose carbon dioxide which is furnished to the root of the stem from which the leaves spring? Now, starting with assent to Prof. Sach's discovery that the starch of the chlorophyll granule is the first visible product of the fixation of some carbon atoms, there was here a ready method of proving whether this were so or not. In the course of several experiments it was contrived that leaves destitute of these starch granules should be in an atmosphere deprived of carbon dioxide, while at the same time they were well exposed to the influence of light. The roots were fixed in moist soil well supplied with carbon dioxide, and the result was that under these circumstances no starch granules were formed; and

in a modification of this experiment, where one portion of a leaf was allowed to be exposed to ordinary air, that portion at once set to forming its starch. Botanists, no doubt, will welcome the publication of the experiments of which we have now only the brief result; doubtless more research will end in more discoveries in this most interesting field, for how can one account for the fact that some plants do, as we might say, fatten by feeding on carbon atoms, although these very plants cannot take these atoms when in union with oxygen?—*Nature, No.* 435, *February* 1878.

Method of Demarcation by means of alternate Trenches.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—A short description of a very simple and effective method employed in demarcating *Rakh* lands in the *Bhua* and *Phalian* ranges of the *Shahpur* and *Gujrat* districts, may interest some of your readers.

It must first, however, be understood that in these ranges neither stones nor lime are procurable, so that bricks would have to be used if boundary pillars had to be constructed, and lime brought from a considerable distance.

It, therefore, seemed to me that a system of alternate trenches with blank spaces between would be the best method of defining the boundaries of these *Rakhs*, which conclusion was principally suggested by observing that the old plough lines, by which means the limits of these jungles were defined, when they were under the charge of the district authorities, were still visible, even though they had not been renewed for three or four years.

After several trials it was found that 50 feet of trench, with 150 feet of break, and again 50 feet of trench defines the boundaries in a very complete manner, it being, of course, necessary in some instances to place the trenches closer or wider apart, towards the end of a line, on account of the length of boundaries from angle to angle not being an exact multiple of 200 feet.

The best dimensions for the trenches are found to be 3 feet wide at top, 1 foot at bottom, and 1½ feet deep, the earth from the trench being thrown back on the inside 2 feet from the edge of the trench, and at the angles 25 feet of trench is dug on each line so as to indicate the direction of the boundaries.

This method of demarcation has cost about Rs. 8 per mile of boundary, whereas the expense of constructing four brick boundary pillars of a substantial kind would be at least Rs. 25 per mile, and the cost of cleaning out the trenches once in three or four years will be very trifling, and much less than that of repairing expensive boundary pillars.

Another advantage of this method is, that the trenches being situated only 150 feet apart, are, of course, much easier distinguished than boundary pillars situated a quarter of a mile apart, especially when the jungle is thick.

It is perhaps unnecessary to observe that this system of demarcation is only applicable to forests situated on nearly level ground, and where there is not much chance of the trenches being rapidly silted up, such as on the banks of rivers or nullahs.

The spoil banks are being sown with *Kikar*, *Phullai* and other tree seeds not common in these *Rakhs*, so that when the trees grow up an additional means of distinguishing the boundaries will be afforded.

Yours faithfully,

E. McA. M.,

Assistant Conservator of Forests.

Assistant Conservator of Forests.

Extracts from "Reports from H. M.'s Consuls of the Manufacture, Commerce, etc., of their Consular Districts, 1877.

PLANTATIONS OF TREES.

1.—*France, Algeria.*

For some years past the Colonists, encouraged by prices and by the successes obtained by the great Companies, have begun to make plantations of trees, amongst which the *Eucalyptus* predominates. To give still further encouragement, the Government has proposed that plantations should be made in every

Commune, and will share the expense. From an inquiry lately held by the Société de Climatologie of Algeria, its results that wherever the *Eucalyptus* has been planted to a large extent, the intermittent fevers so common in the marshy districts have *diminished in frequency* and intensity. This, however, I have made the subject of a separate report.

Alfa.

Notwithstanding the difficult, expensive and imperfect means of transport, the export of Alfa continues to increase. During the second half-year of 1875, and the first of 1876, 45,000 tons have been exported from one place alone. A new development will soon be given to this branch of Algerian industry; new lines of railways are in course of construction, and large concessions of the land on which it grows have been granted to them; thus 233,000 hectares have been farmed for the sum of 160,000 fr.

The European nations import Algerian Alfa in the following porportions:—

	Per cent.
England buys of the whole produce	72
Spain	18*
France	4
Belgium	3·5
Portugal	2·5

The average price per ton is 145 fr. in the port of Oran. The whole traffic of the province is about 1,000,000 kilos.

Forests.

1.—*Persia.*

In the year 1876, 2,170 tons of boxwood were cut down in the province of Ghilan, making about 60,000 pieces. When it is considered that scarcely more than one piece can be got out of one tree, and that thence upwards of 200,000 trees were hewn down last year alone in Ghilan and Mazenderan, it will be readily understood that however thick the jungle may be, *this extensive cutting down of the forests must* have an effect

* This is principally for re-exportation to England.

on the climate of these regions; and it is to be observed that within the last few years, in fact since boxwood has been cut and rice cultivated, a much smaller amount of rain has fallen on the side of the Elburz Mountains, which tends to make the country less feverish and unhealthy than it was in days gone by.

Olive Oil.

2.—*Persia.*

The olive groves of Rudbar yield a very fair quantity of oil; but its quality, as a general rule, is very inferior, and is only suited to the manufacture of common soap. In proper hands its value might be considerably enhanced. A small quantity of salad oil is produced by the Armenians equal in flavour and clearness of colour to the best Italian oil. Some specimens of this article of trade in its purified condition have been sent to Teheran by the Naser-ul-Mulk, who takes a great interest in the development of the resources of the country, is a specimen of what it can produce; and it has been highly approved of. There is ample room for the establishment at Rudbar of several oil presses propelled by the waters of the Sefedrood, and the opening up of a great trade in this branch of industry. The price of olives on the spot is 3*s.* 6*d.* per cwt.

Mazenderan.

3.—*Persia.*

During the early part of the year the district of Tenekaboun exported 5,800 tons of boxwood, Messrs. Vasiliades & Co. having cut down nearly 170,000 trees to effect this object. Every piece of boxwood worth exporting must be of at least 9 inches in diameter and between 4 and 5 feet in length; the wood must be straight and be free from cracks; each piece weighing on an average 70lbs. On the Coast the 1,000 pieces are worth from 120*l.* to 160*l.* The boxwood of Tenekaboun is superior to that of Ghilan.

The wood cut down in 1876 was sent to Roston for transmission to England; but the market being overstocked, and rumours of war being afloat, it is unlikely that Messrs. Vasiliades & Co. will cut down any more wood in 1877. Merchants who last year invested money in this article lost by it.

Screw-jack or Cant-hooks.

TO THE EDITOR OF THE "INDIAN FORESTER."

DEAR SIR,—I should be glad to hear if any of your readers has seen the "*Screw-jack or Cant-hooks*" made use of in the working of a forest in India or the Continent of Europe? I had never seen either before I went to New Zealand, where one or other is invariably used in "exploitation" to even better advantage than the "*krempe*" in the Black Forest.

Should their use be unknown to us, I purpose sending you descriptions and drawings; and importing specimens for introduction into our forests.

Faithfully yours,
J. CAMPBELL WALKER.

MADRAS CLUB, *7th January* 1878.

Planting in Bamboo Tubes.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—With reference to the method of planting in bamboo tubes ~~or pots~~ described in October number, it may be worth noting that the plan has been tried preliminarily, and will be generally to some extent, in the Bangalore plantations, next planting season. It seems eminently fitted for use in the western forests; in the case of Teak some cheap expedient being required to root the plants, before the dry season is upon them, more deeply than in a state of nature. In a drier climate the following objections occur to the use of these bamboo sections as described. Four or five inches is much too small, and an increase of diameter must go with increased length, giving as a result nothing more than a clumsy and costly pot.

The bamboo section, unless small and *tender*, (as Mr. Routledge put it), would only rot away, at once, in a damp climate. Pieces of the ordinary bamboo about here, an inch internal diameter, have been in wet soil for months, and show no sign of rotting. I may here state that sections 4″, 8″ and 12″ long with plants of *Casuarina equisitifolia*, *Eugenia jambolanum*,

and *Terminalia tomentosa* were put out last September. They were properly watered and cared for, and taken up and inspected monthly. They made little growth during the first two months. Afterwards, the *Terminalia* died out, but some of the others came on, and at the present time seem to have adapted themselves to the conditions. Of the 40 plants in 40 pipes there remain now

4″ pipes	...	8 plants now alive, of which 6 have got their roots showing at the bottom of the pipe.
8″ pipes	...	10 plants now alive, none with roots showing.
12″ pipes	...	Ditto. ditto.

They average 3″ in height.

It has been found by experience that in this climate young trees must be put out with their roots *intact* to the depth of a foot, and be in the way of rapidly extending them downwards two feet more, before the first dry season—a condition which requires something more than bits of bamboo for its fulfilment.

KAD-HANDI.